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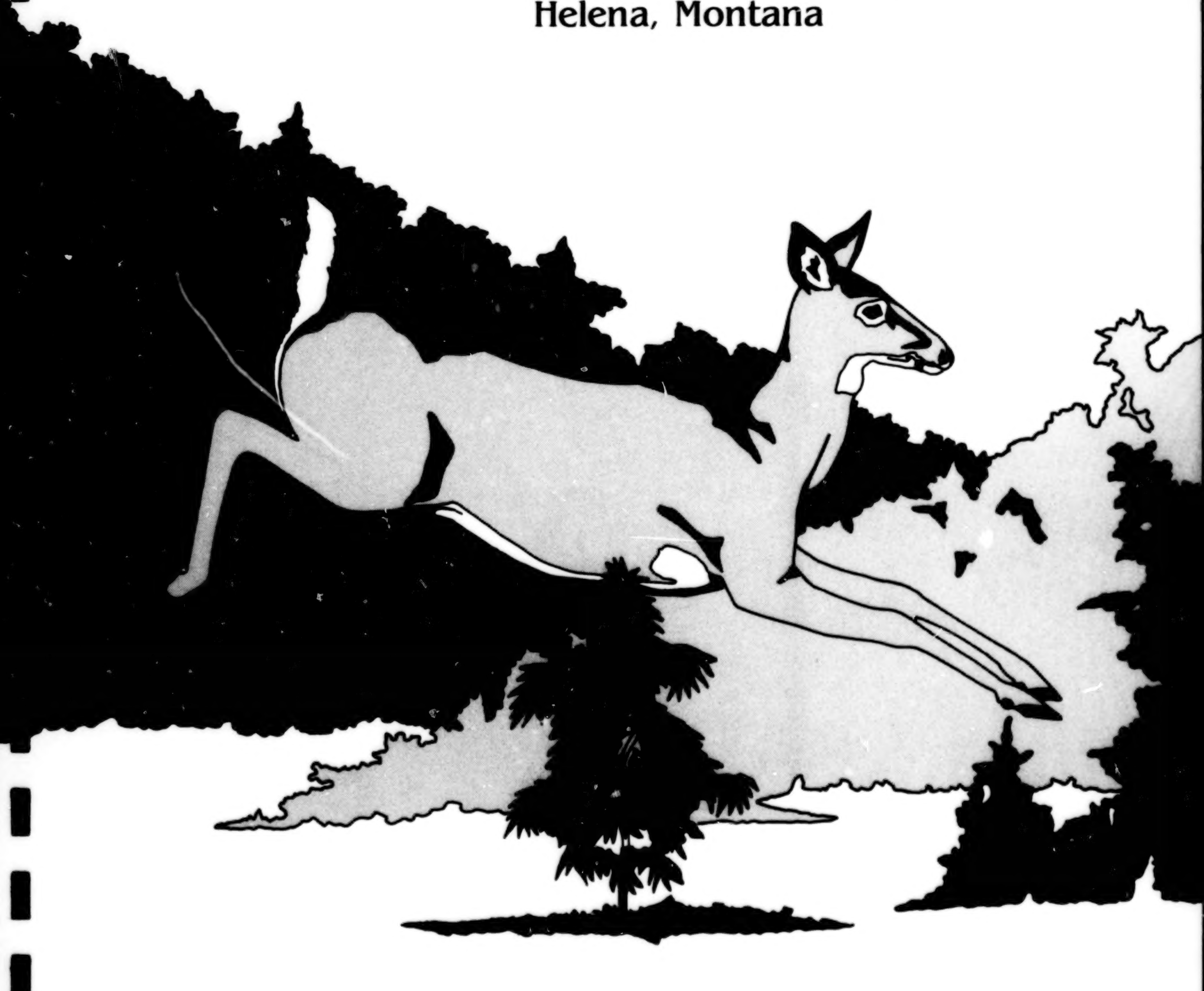
Blue Ridge Parkway

Traffic Safety Study
North Carolina and Virginia

prepared by
Robert Peccia & Associates
Helena, Montana



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BLUE RIDGE PARKWAY
TRAFFIC SAFETY STUDY

North Carolina And Virginia

U.S. Department of the Interior
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This document reflects the views of Robert Peccia & Associates, who are responsible for the accuracy of the data presented in this study. The contents do not necessarily reflect the official views or policies of the National Park Service or the administrators of the Blue Ridge Parkway. Acceptance of this document by the National Park Service does not in any way constitute a commitment on the part of the United States to participate in any development depicted herein nor does it indicate that the proposed development is in accordance with public laws relating to the environment.

Executive Summary

Introduction and Purpose

The purpose of this study was to define the physical and operational characteristics of the Blue Ridge Parkway, analyze its accident history, identify traffic safety problems or physical deficiencies, and develop a set of recommendations that address identified problems. The study included a general review of the Parkway road system and a detailed examination of 20 locations where a high frequency of accidents occurred during the study period. The specific comments and recommendations contained in this document are intended to assist the National Park Service (NPS) to bring the Parkway road system into conformance with national safety standards and practices.

Summary and Conclusions

The Blue Ridge Parkway serves its primary function as a scenic roadway well. The layout and design of the facility is effective and conforms to most nationally-accepted roadway design standards. The major deficiencies observed on the Parkway were related to traffic controls (signing and striping) and the lack of adequate sight distance. Signing deficiencies included the use of some undersized signs, improper sign placement, and the lack of appropriate warning signs in some curves on the Parkway.

Centerline striping on the Parkway was evaluated during a special study which identified all passing and no-passing zones. The results of the striping evaluation have been included with this document.

Some areas along the Parkway, including intersections and overlooks, have sight distance limitations caused by roadside vegetation or terrain. Such limitations have been specifically identified at the 20 sites on the Parkway where detailed evaluations were performed. Sight distance limitations can be easily eliminated in many cases by the removal of a few trees or shrubs.

The accident studies undertaken for this project included an examination of 1,499 accidents which occurred between January 1, 1984 and December 31, 1987. The subsequent analysis of these records determined that the Blue Ridge Parkway had an overall accident rate of 2.50 accidents per million vehicle miles traveled (ACC/MVMT) during the study period. This accident rate was less than the average accident rate for 10 other units of the National Park System (3.33 ACC/MVMT) developed by the NPS. Although the accident rate was lower than the NPS's average for 10 parks, the severity of the accidents on the Parkway was higher than that of other NPS road systems. Analyses showed that the Parkway had an injury accident rate of 75.65 ACC/100 MVMT and a fatality accident rate of 4.01 ACC/100MVMT. Both of these severity accident rates were higher than the corresponding rates of 68.18 ACC/100 MVMT and 3.17 ACC/100 MVMT for other NPS roads.

A major portion of this study was devoted to the identification of unsafe conditions at 20 high-accident frequency locations on the Parkway. A list of improvements or recommendations was developed to address problems at each site. These recommendations are primarily intended to provide positive guidance to visitors through the use of conventional signing and striping techniques and to improve sight distance within the existing corridor of the Parkway. The total cost (in current dollars) of the improvements is estimated to be $460,950.

A Priority Ranking has been provided to assist the NPS in determining an order for implementing the recommended improvements. This ranking considered the relative hazardousness of each site and the cost of the improvements to prioritize the proposed improvements at the 20 high-accident frequency locations. The relative hazardousness of each site was evaluated through the calculation of a Hazard Index, which was based on three accident indicators (number of accidents, accident severity, and accident rate) and three "non-accident" indicators (sight distance ratio, driver expectancy, and information system deficiencies). A detailed explanation of the factors involved in calculating the Hazard Index and the Priority Ranking is presented in Appendix D of this report. The Benefit/Cost Ratio, Hazard Index, and Priority Ranking for each site are shown below.

Priority Ranking of the Recommended Improvements

Priority Ranking	Site No.	Milepost	Site Description	Improvement Cost	Benefit Cost Ratio	Hazard Index	Priority Index
*1	18	384.6 - 384.8	Junction with U.S. 74	$ 17,000	1.09	69.00	75.25
2	1	1.0 - 1.2	Curves north of Rockfish Valley Overlook	2,400	11.68	64.15	72.61
3	20	451.0 - 451.2	Waterrock Knob	21,400	1.09	65.67	67.25
4	12	217.1 - 217.3	Junction with State Route 18	9,900	3.49	59.31	66.98
5	4	82.9 - 83.1	Fallingwater Cascades	8,100	1.55	62.68	66.51
6	16	291.7 - 291.9	Junction with U.S. 321/221	19,150	1.30	58.52	66.39
7	7	121.0 - 121.2	Junction with U.S. 220	45,100	0.91	62.39	66.29
8	2	6.9 - 7.1	Curves south of Humpback Gap	18,700	1.72	65.92	65.94
9	10	199.8 - 200.0	Junction with State Route 778	9,250	1.22	53.98	63.49
10	14	289.2 - 289.4	Curve north of Raven Rock Overlook	4,750	4.10	52.06	62.80
11	19	387.8 - 388.0	Curve north of U.S. 25	17,000	1.05	47.43	60.07
12	3	37.3 - 37.5	Irish Gap	5,400	3.72	52.36	59.77
13	13	286.9 - 287.1	Curve north of Aho Gap	37,700	1.02	58.30	58.73
14	9	199.3 - 199.5	Junction with U.S. 52	19,200	1.43	47.45	58.09
15	11	205.8 - 206.0	Curve north of Piper's Gap	17,400	3.34	49.50	57.63
16	6	90.7 - 90.9	Curve north of Bearwallow Gap	25,400	1.02	67.89	57.42
17	15	290.9 - 291.1	Green Hill	2,700	1.66	42.14	55.86
18	17	382.0 - 382.2	Junction with U.S. 70	24,200	1.03	42.36	55.77
19	5	85.8 - 86.0	Peaks of Otter	115,000	0.68	68.63	53.97
20	8	128.0 - 128.2	Curve north of Metz Run Overlook	41,200	1.05	58.62	48.97
Total Improvement Costs:				$460,950			

* The NPS installed a series of chevron warning signs at this site in 1988 which should produce a significant reduction in accidents. The priority index was calculated based on the accident history at the site during the period from 1984 through 1987 and, therefore, does not reflect these recent improvements.

A benefit/cost ratio was calculated for the improvements at each site and is shown in the table above. This ratio is greater than one in all but two cases. The ratio for Site 7 is low because of the minor severity of the accidents at this location. The benefit/cost ratio for Site 5, Peaks of Otter, is low due to the relatively high cost of the recommended improvements. Although the ratios at these two sites are low, the recommended improvements are considered desirable with respect to traffic safety.

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Chapter I: Introduction

A. Project Purpose and Goals

The purpose of the Blue Ridge Parkway Traffic Safety Study is to provide the National Park Service (NPS) with the planning necessary to bring the Parkway into conformance with national safety standards and to justify funding requests for safety improvement projects outlined in this report. Specific project goals include the following:

- Define the physical and operational characteristics of the Parkway;
- Analyze the vehicle-accident history of the Parkway;
- Identify and evaluate system-wide traffic safety problems;
- Identify specific locations on the Parkway that historically have a high frequency of accidents;
- Examine each high-accident "frequency" location and identify any problems, deficiencies, or hazards that may exist;
- Propose improvements to alleviate the system-wide traffic problems and any hazardous conditions identified at the high-accident "frequency" locations;
- Develop a means of prioritizing recommended improvements to facilitate implementation by NPS maintenance personnel; and
- Generate guidelines for monitoring and updating the traffic safety needs of the Parkway.

B. Project Study Area

The Blue Ridge Parkway is a two-lane, limited access highway that follows the crest of the Blue Ridge Mountains through North Carolina and Virginia. This 469-mile-long, scenic roadway links the Shenandoah National Park in Virginia and the Great Smoky Mountains National Park in North Carolina. The regional location of the Blue Ridge Parkway is shown in Figure 1.

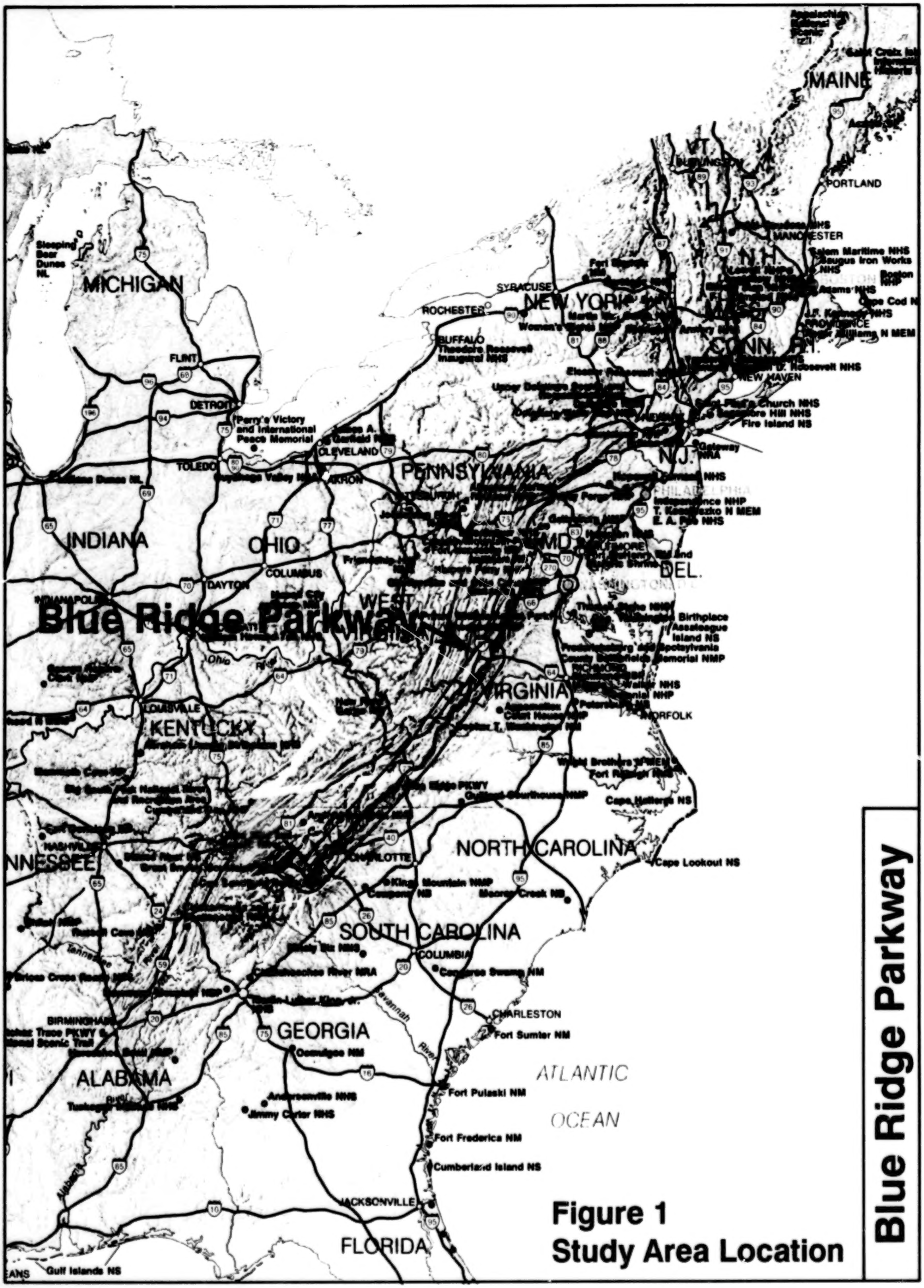


Figure 1
Study Area Location

Chapter II: Physical Characteristics of the Parkway

A. General

The Blue Ridge Parkway was specifically designed and is managed to provide visitors with scenic views of the southern Appalachian Mountains and access to historic sites, trails, picnic areas, campgrounds, museums, craft centers, and accommodations. Construction of the Parkway began in 1935 and was substantially completed by 1969. The last portion of the Blue Ridge Parkway to be constructed was a seven-mile-long section around Grandfather Mountain in North Carolina. This final project was completed in 1987 and included construction of the Linn Cove viaduct, a 1,243-foot-long bridge, that traverses environmentally-sensitive areas on the face of Grandfather Mountain.

The focus of this chapter is to examine the physical features of the Parkway and the roadside developments.

B. Parkway Road System

1. Parkway Access

The Parkway is a limited access facility with public access points confined to approximately 46 locations where the Parkway intersects major state highways and county roads. There are also numerous low-volume, private approaches, which are necessary and comprise the primary access to adjacent landholdings. The NPS has minimized the number of such approaches while satisfying the needs of the Parkway's more than 5,000 adjacent landowners.

2. Roadway Design

The Parkway was constructed within a right-of-way corridor averaging 1,000 feet in width. Additional right-of-way has been acquired to accommodate large wayside attractions. The "main line" of the Parkway is a 2-lane, 2-way, undivided roadway. The typical road section consists of a 21-foot-wide paved driving surface constructed on a crushed stone base with a minimum of 4.5-foot-wide, stabilized, turf shoulders.

The pavement has been crowned and the shoulder areas sloped away from the road centerline to provide for proper drainage of surface moisture. It has been widened and superelevated in the curve sections. The Parkway is designed for 45 mile-per-hour (mph) travel speeds with maximum roadway grades of between 6 to 8%, and curves with a standard minimum radii of 500 feet. The absolute minimum radii for curves on the Parkway is 200 feet.

Many of the roads that provide access and circulation to Parkway attractions and developed areas are of similar design as the "main line", although one-way roads of varying widths are also used in these locations. The Parkway has several spur roads that connect with the main roadway including the Roanoke Mountain Road, a 3.7-mile-long, one-way loop; the 2.4-mile-long Mill Mountain Road near Roanoke; and the Heintooga Ridge Road, a 1.3-mile-long road near the southern terminus of the Parkway.

3. Intersections

Grade-separated intersections are used at locations where major state and county roads cross the Parkway. A bridge is used to route the Parkway over the cross road, and access is provided by connecting ramps. Access ramps intersect the Parkway and the adjoining route at-grade producing standard "T" intersections. The geometric layout of each interchange varies depending on the individual conditions at the site. Where a divided highway crosses the Parkway, two access ramps have been provided. This design has been effectively used to minimize the impacts of cross-traffic while providing for uninterrupted traffic flows on the Parkway.

A standard at-grade "T" intersection or "four-way" intersection design is used where the Parkway intersects a low-volume road. Traffic control is provided by stop signs on the cross road approaches.

4. Raised Channelization

Raised channelization is often used to delineate triangular- shaped median islands at intersections. These turf-covered median islands are typically bordered with a six- to eight-inch high granite curb. Similar channelization techniques are used at many roadside parking areas to physically divide the "main line" traffic from the parking area traffic and to delineate the access points. Raised channelization, which varies in size and shape, is also used in many developed areas to control and direct traffic flows.

5. Drainage

Most areas of the Parkway are designed to transport surface water from paved areas via shallow, grass-lined drainage ditches that parallel the roadway. Asphalt or stone-lined drainage ditches are used in conjunction with drop inlets and subsurface culverts in many cut sections. These isolated subsurface drainage systems typically consist of relatively short culvert runs that route the water to the nearest acceptable receiving area. Subsurface drainage systems are also used in some developed recreation sites.

Larger drainage structures such as box culverts and bridges are used for creek and river crossings of the Parkway.

6. Parkway Signing and Striping

The signing system on the Blue Ridge Parkway consists of regulatory and warning signs, state and county route markers, and unique Parkway guidance and informational signs. The Parkway is posted with 45 mph speed limit signs. There are several reduced speed zones located near major developed areas at Peaks of Otter, Mabry Mill, Cumberland Knob, Doughton Park, Price Park, Craggy Gardens, and Mt. Pisgah. The Parkway is also signed to prohibit use by commercial vehicles. Traffic control at all public approaches is provided by stop signs. A majority of the approaches from roadside parking areas and developed areas are controlled by stop or yield signs. Most low-volume, private approaches lack traffic control signs. The predominate warning sign on the Blue Ridge Parkway is the curve sign, which is often accompanied by an advisory speed plate. Roadside delineators or object markers are rarely used. Various types of seasonal and maintenance signing is used when necessary.

Signs that are unique to the Parkway include the large, wooden entrance signs, "Overlook Ahead" signs, "Exhibit Ahead" signs, north-south directional signs, and other informational signs. The entire length of the Parkway is referenced using milepost markers with milepost (MP) 0.0 at the northern end and MP 469 at the southern terminus.

Pavement markings consist of centerline striping on all two-way sections. Shoulder striping is only used inside the Parkway's tunnels. Other pavement markings include stop bars, pedestrian crosswalks, and delineation within parking and/or developed areas.

7. Tunnels

Only one (the Bluff Mountain Tunnel at MP 53.1) of the 26 tunnels constructed on the Parkway is located in Virginia. All other tunnels are located between MP 333.4 and 466.3 in North Carolina. The Parkway tunnels typically have concrete-lined openings. The arched openings are reinforced with stone and mortar rockwork which extends above the top of the tunnel. Tunnels are typically 30 feet wide at the base with ceiling clearance heights ranging from 12 feet at the edge of the driving lane to 19 feet at the roadway centerline. Tunnels vary in length fron 176 feet to 1,320 feet. Although the tunnels are not lighted, they are equipped with various forms of reflectors and paint striping. A summary of the tunnel features is included in Table 8 contained in Chapter V of this document.

C. Parkway Facilities

1. Developed Areas

Developed recreation areas are considered essential to the function of the Parkway. There are 22 major developed areas that offer visitors a variety of services including visitor information, lodging, food, restrooms, and gasoline. Various recreational activities, such as camping, picnicking, boating, fishing, and hiking, are available at many developed areas. Information pertinent to the history and crafts of the Appalachian region and the natural environment is provided at several developed areas through presentations by rangers, self-guided trails, demonstrations, museums, and craft exhibits. The facilities available at each developed area are shown in Table 1.

Table 1
Parkway Developed Areas and Visitor Facilities

	Visitor Center	Gift,Book or Craft Sales	Demonstrations	Gasoline	Food	Lodging	Picnicking	Self-Guided Trails	Camping	Camp Store	Hiking	Fishing
5.8 Humpback Rocks	■	■	■				■	■			■	
29.0 Whetstone Ridge		■		■	■							
60.9 Otter Creek		■			■				■		■	■
63.8 James River	■	■					■	■				■
86.0 Peaks of Otter	■	■		■	■	■	■	■	■	■	■	■
120.4 Roanoke Mountain									■		■	
154.5 Smart View							■				■	
169.0 Rocky Knob	■	■				■	■		■		■	■
176.1 Mabry Mill		■	■		■			■				
217.5 Cumberland Knob	■	■					■				■	
238.5 Brinegar Cabin			■								■	
241.1 Doughton Park		■		■	■	■	■		■	■	■	■
258.6 Northwest Trading Post		■	■									
272.0 E.B.Jeffress Park							■	■			■	
294.1 Moses H.Cone Mem. Park	■	■	■					■			■	■
297.1 Julian Price Mem. Park							■		■		■	■
316.4 Linville Falls		■					■		■		■	■
331.0 Museum of N.C. Minerals	■	■										
339.5 Crabtree Meadows		■		■	■		■		■	■	■	
364.6 Craggy Gardens	■	■					■	■			■	
382.0 Folk Art Center	■	■	■									
408.6 Mount Pisgah		■		■	■	■	■		■	■	■	

There are also 11 NPS maintenance areas spaced along the Parkway. Facilities at these locations include the field headquarters of the maintenance foreman, the district ranger's office, and storage areas for maintenance equipment.

2. Roadside Exhibits, Overlooks, and Parking Areas

There are approximately 255 roadside areas along the Parkway. These small developed sites have paved parking areas capable of accommodating 5 to 30 vehicles depending on the size and layout. Each wayside provides visitors with an opportunity to stop and experience historical, archaeological, and mineral exhibits; visitor information displays; picnic tables; self-guided trails, and photo opportunities.

Typically, roadside areas are signed in advance. Traffic control at these sites is limited to stop or yield signs and painted stop bars at Parkway access points. Individual parking stalls have been defined with pavement markings in larger parking areas. Special parking spaces for oversized vehicles, such as recreational vehicles (RV's), are delineated in some areas. A curb and sidewalk is normally provided at the front end of parking stalls.

The size and layout of each wayside varies with the natural topography and available facilities. Some of the smaller waysides are located immediately adjacent and parallel to the Parkway while others are set back from the Parkway and accessed by short roads. Waysides that are away from the main road typically have a landscaped island separating the parking area from the Parkway. Many smaller median islands are defined with raised granite curbs.

3. Pedestrian and Bicycle Facilities

All major developed areas have concrete or asphalt walkways leading from parking areas to the major attractions and visitor facilities. Short sections of sidewalk are provided at most wayside parking areas, and hiking trails are available at approximately 75 roadside areas. The Appalachian Trail, which extends from Maine to Georgia, roughly parallels the Parkway from milepost 0.0 to 103.0 and crosses it at 9 locations.

No separate bicycle facilities exist on the Parkway or at any of the developed areas. Bicycle use is restricted to the paved roadway and must comply with the rules and regulations that apply to motor vehicles. Bicyclists must travel in the driving lanes of the Parkway since there are no paved shoulders. There are no pedestrian or bicycle facilities in any of the tunnels. Bicycling is a popular activity on the Parkway, and is growing annually, even though facilities are limited.

Chapter III: Operational Characteristics of the Parkway

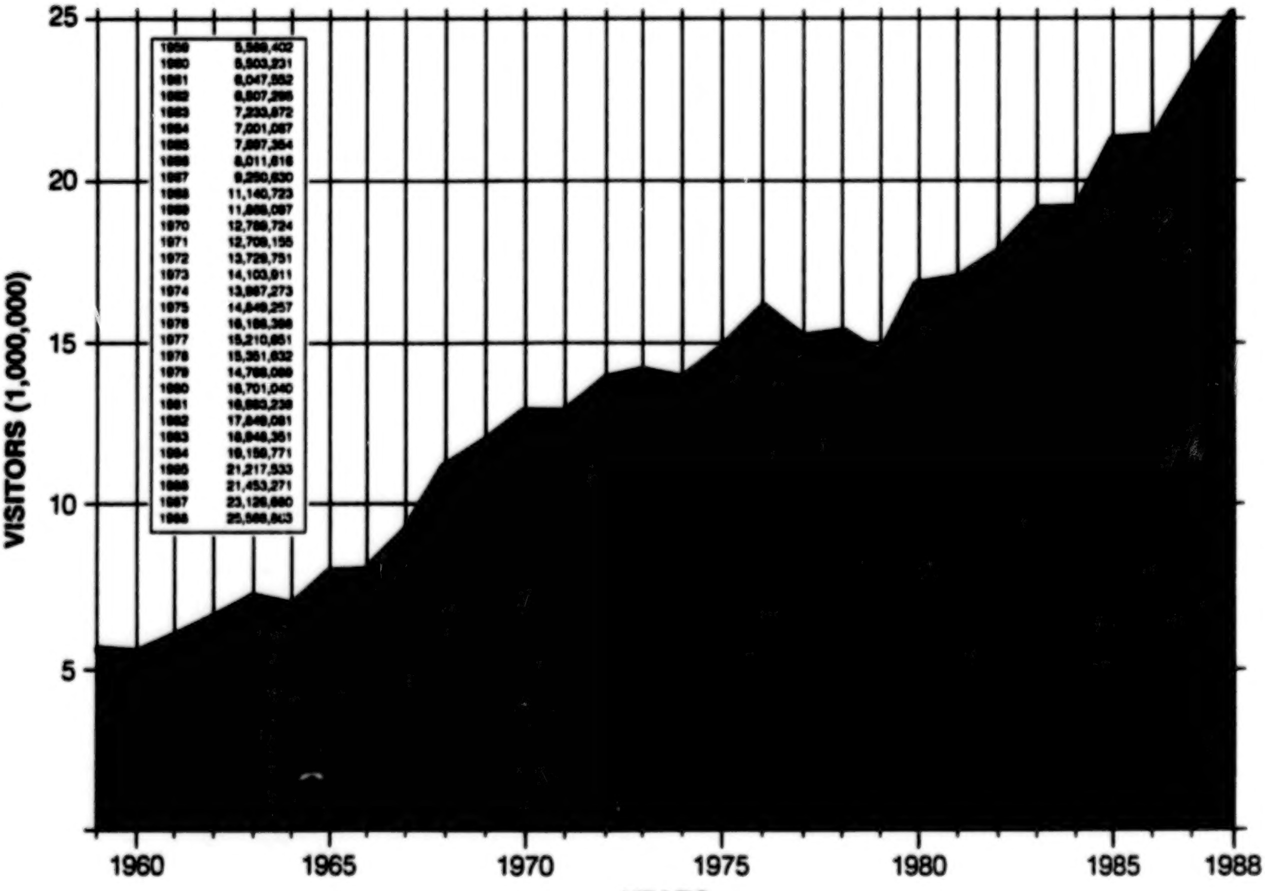
A. General

The operational characteristics of a transportation system can be best defined by reviewing available data on historical use and by performing traffic studies that measure specific aspects of the existing system. A proper assessment of visitor usage and the operation of the road system is fundamental to identifying safety problems or deficiencies. The following narrative examines visitor use patterns on the Parkway, describes the types of traffic tests performed during June and October of 1988, and summarizes the test results.

B. Visitation

Parkway visitation is monitored by NPS using 56 vehicle entrance counters located at major access points. These counters employ pressure-type tubes and pneumatic counters to

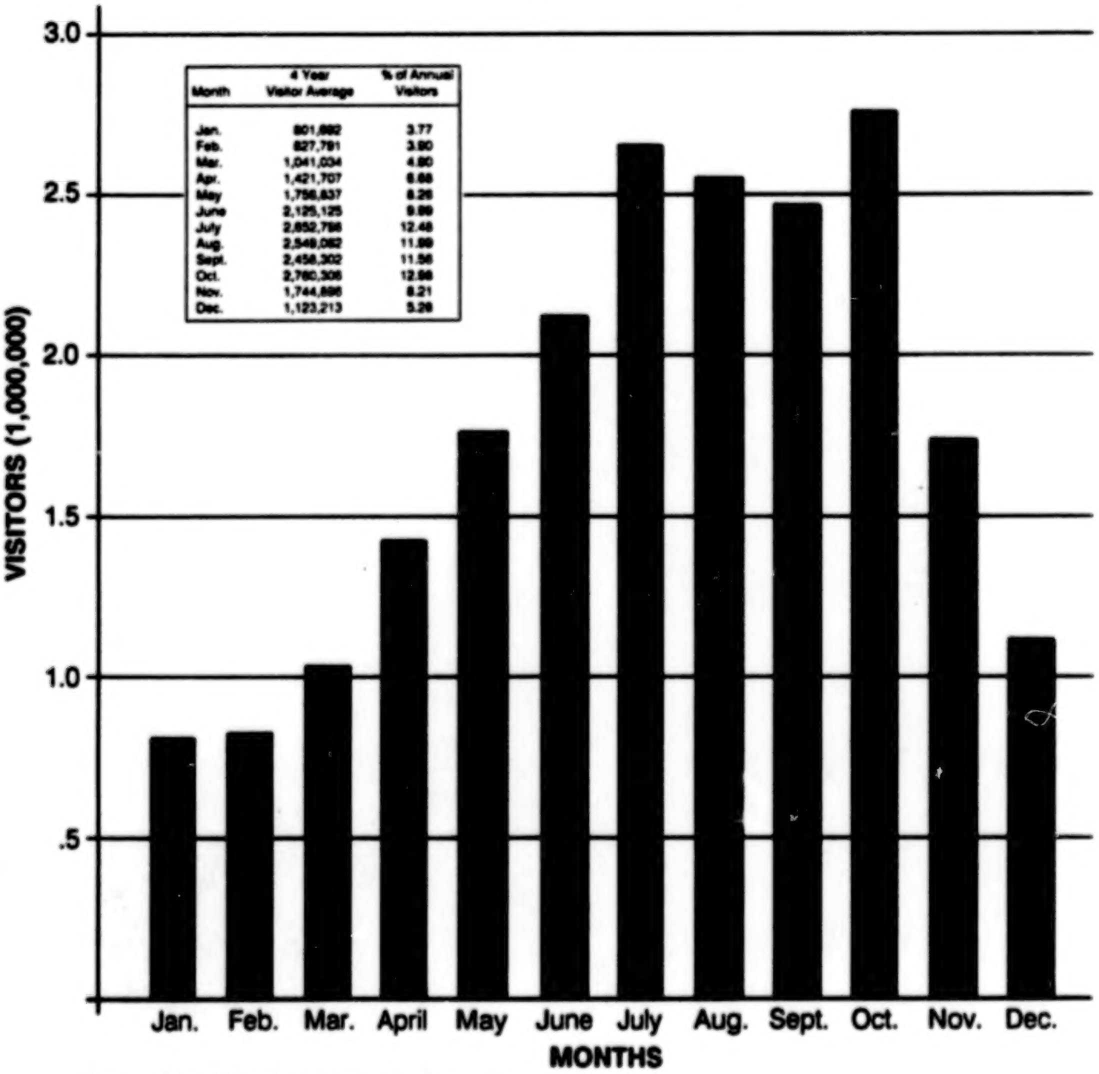
Figure 2
Annual Parkway Visitation



1959	5,569,402
1960	5,503,231
1961	6,047,552
1962	6,607,295
1963	7,233,972
1964	7,001,087
1965	7,897,364
1966	8,011,818
1967	9,290,630
1968	11,140,723
1969	11,888,087
1970	12,789,724
1971	12,709,155
1972	13,729,751
1973	14,103,911
1974	13,987,273
1975	14,849,257
1976	16,169,399
1977	15,210,851
1978	15,351,632
1979	14,768,089
1980	16,701,040
1981	16,980,239
1982	17,849,081
1983	18,948,351
1984	19,159,771
1985	21,217,533
1986	21,453,271
1987	23,128,880
1988	25,569,863

Source: Blue Ridge Parkway Visitor Count Records record entrance traffic volumes at each location. These counts are collected by district rangers and provide the basis for estimating Parkway visitation. Annual visitation from 1959 through 1988 is presented on Figure 2. As illustrated, annual visitation has increased steadily over the past 30 years and is currently increasing at about 5% per year. Visitation declined during the 1970's due primarily to high fuel prices in 1974 and the economic recession near the end of the decade. Over 25 million people visited the Blue Ridge Parkway in 1988.

Figure 3
Monthly Variation in Visitation
(Based on Four-Year Average 1984-1987)



Month	4 Year Visitor Average	% of Annual Visitors
Jan.	801,892	3.77
Feb.	827,791	3.90
Mar.	1,041,034	4.90
Apr.	1,421,707	6.68
May	1,756,837	8.26
June	2,125,125	9.99
July	2,652,798	12.48
Aug.	2,549,082	11.99
Sept.	2,458,302	11.56
Oct.	2,760,308	12.98
Nov.	1,744,898	8.21
Dec.	1,123,213	5.28

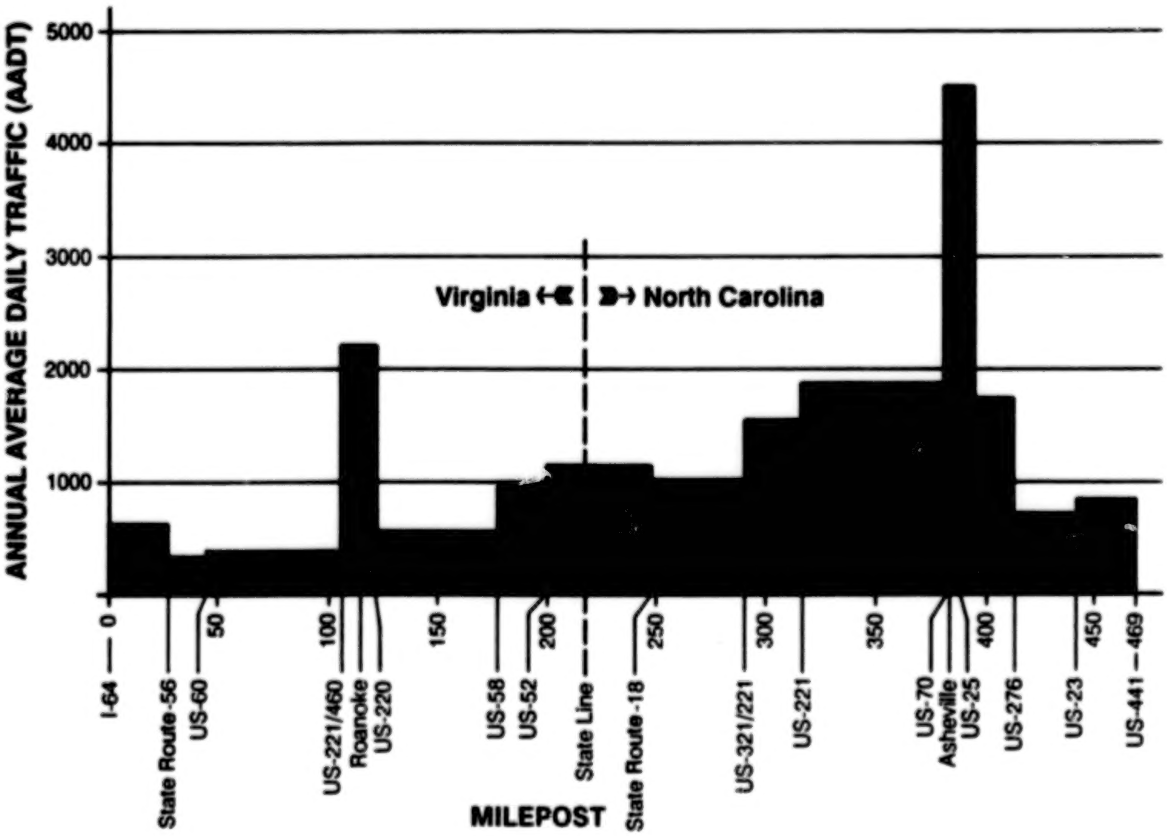
Source: Blue Ridge Parkway Visitor Count Records

A breakdown of visitation count records was used to define seasonal variations in Parkway use. Figure 3 shows average monthly visitation for the 1984 through 1987 period. Based on this data, it was determined that the peak visitation period is June through November. Approximately 70% of the total annual visitation occurs during these six months. October experiences the greatest percentage of visitors (12.98%), while February has the lowest percentage (3.77%).

C. Traffic Volumes

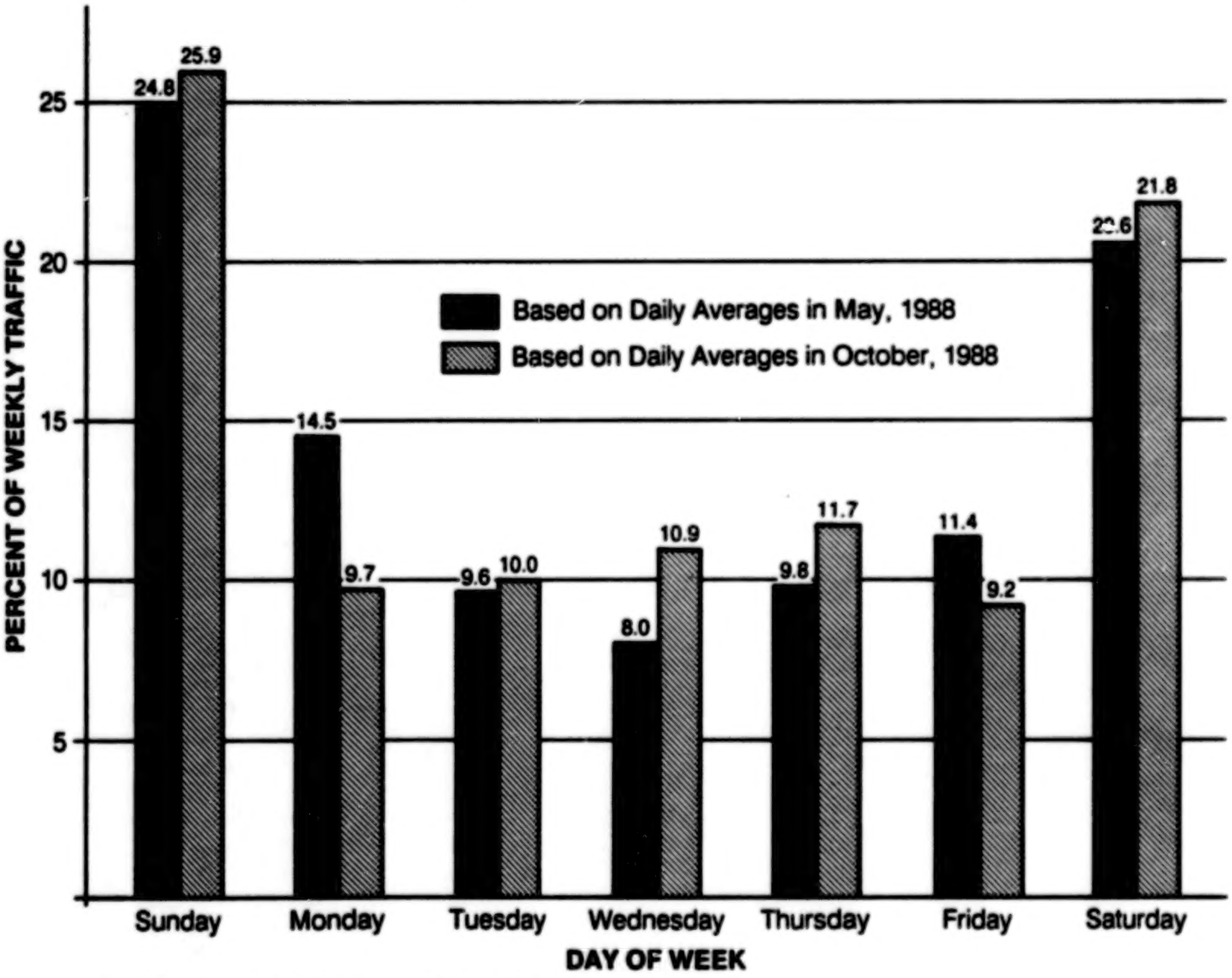
The NPS maintains two permanent traffic counters on the Blue Ridge Parkway. One counter is located at Rockfish Gap (MP 0.0), and the other is near the Oconalauftee River Bridge (MP 469). These permanent counters provide the only long-term record of actual traffic volumes on the Parkway. The permanent traffic counter data was supplemented with spot machine counts taken at 12 locations along the Parkway during June of 1988 for the purposes of this study. The spot traffic count data was adjusted to represent average annual daily traffic (AADT) using seasonal adjustment factors developed from the permanent traffic counter data. The traffic volume distribution along the Parkway is shown in Figure 4. The highest volumes were recorded in the Roanoke and Asheville areas (MP 120 and MP 390) where the Parkway is used by commuter traffic. It was determined from this data that 62% of all vehicle miles traveled on the Parkway occur in North Carolina and 38% in Virginia.

Figure 4
Parkway Traffic Volume Distribution



The permanent traffic counter data was used to further identify traffic volume characteristics on the Parkway. The typical traffic volume distribution, shown in Figure 5, is based on the average volumes in May and October. The data indicates that 45% of the traffic on the Parkway occurs on weekends. This finding is as expected for a route used by recreational traffic.

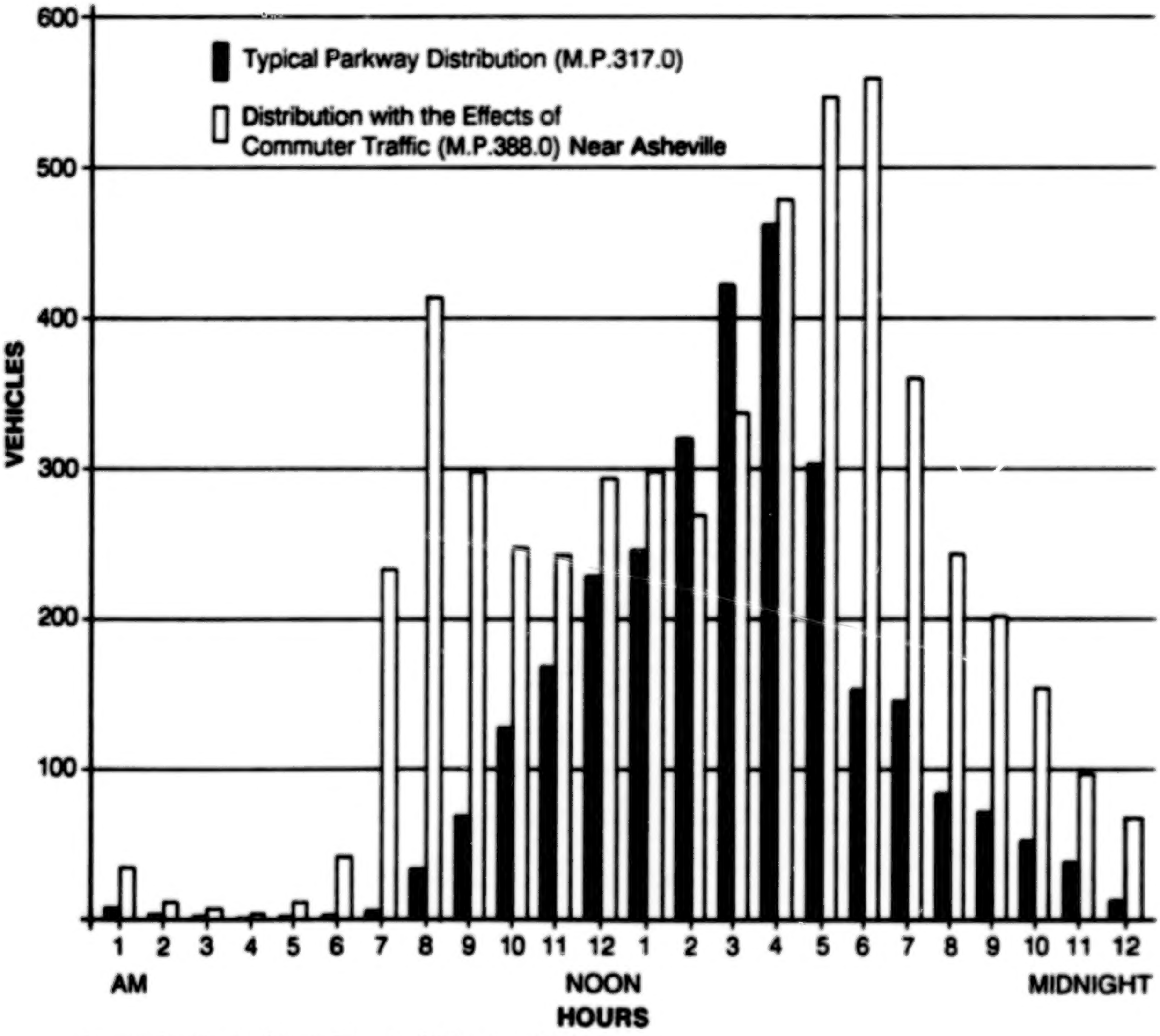
Figure 5
Typical Traffic Volume Variations During the Week



Source; Permanent Traffic Counter at Rockfish Gap

The typical daily traffic distribution by hour was developed from the results of the spot traffic counts taken along the Parkway. This data, presented in Figure 6, shows the variation in daily traffic volumes typical of most Parkway locations and the daily variation in traffic that occurs in the Asheville area where commuter traffic exists. As indicated by the figure, the peak travel hours on the Parkway generally occur between 10:00 a.m. and 6:00 p.m. The volumes grow steadily, beginning at 7:00 a.m., with the peak hour usually occurring at 3:00 or 4:00 p.m. Traffic volumes are extremely light between midnight and 6:00 a.m. There is a sharp increase in volume between 7:00 and 9:00 a.m. and a similar increase between 5:00 and 6:00 p.m. in those areas where commuter traffic exists. Significantly more traffic also occurs from 10:00 p.m. until 6:00 a.m. at locations used by commuters.

Figure 6
Hourly Variations in Daily Traffic



Source: Spot Traffic Counts Taken by RPA In June,1988

D. Vehicle Classification

Vehicle classification studies were performed in conjunction with manual turning movement counts at 14 locations on the Parkway during October and early November of 1988. Vehicle classifications identified by the traffic studies included passenger vehicles and pick-ups, recreational vehicles, motorcycles, vehicles with trailers, light trucks (trucks with more than 4 tires), and buses. Over 10,000 vehicles were observed and classified during peak hours at each site as part of this study. Table 2 summarizes the results of the vehicle classification counts.

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Table 2
Vehicle Classification Summary

Date of Observation	Milepost	Total Vehicles Observed	Passenger Vehicles/ Pickups		RV's/ Motor Homes		Motorcycles		Vehicles with Trailers		Light Trucks		Buses	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
11/07/88	86.0	172	168	97.6	0	-	2	1.2	0	-	2	1.2	0	-
11/05/88	121.0	331	324	97.9	1	0.3	5	1.5	1	0.3	0	-	0	-
11/06/88	121.2	297	293	98.7	0	-	3	1.0	1	0.3	0	-	0	-
10/30/88	199.5	699	689	98.6	6	.9	3	0.4	1	0.1	0	-	0	-
10/30/88	199.7	793	771	97.2	6	0.8	8	1.0	7	0.9	1	0.1	0	-
10/29/88	200.0	403	399	99.0	0	-	0	-	4	1.0	0	-	0	-
10/29/88	217.2	261	246	94.3	11	4.2	0	-	3	1.1	0	-	1	0.4
10/26/88	291.7	469	448	95.6	9	1.9	3	0.6	6	1.3	1	0.2	2	0.4
10/26/88	291.9	476	455	95.6	15	3.2	2	0.4	3	0.6	1	0.2	0	-
10/24/88	382.0	775	736	95.0	20	2.6	10	1.3	5	0.6	3	0.4	1	0.1
10/24/88	382.2	600	582	97.0	10	1.7	5	0.8	2	0.3	0	-	1	0.2
10/22/88	384.8	1,487	1,446	97.3	22	1.5	11	0.7	8	0.5	0	-	0	-
10/22/88	385.0	2,150	2,106	98.0	19	0.9	15	0.7	7	0.3	1	*	2	*
10/23/88	451.0	1,252	1,209	96.5	19	1.5	17	1.4	7	0.6	0	-	0	-
Total All Observations		10,165	9,872	97.1	138	1.4	84	0.8	55	0.5	9	*	7	*

* Less than 0.1%

The data in the table indicates that 97% of all vehicles observed on the Parkway are passenger vehicles or pickups. Recreational vehicles accounted for 1.4% of the total traffic observed with motorcycles representing 0.8% of the traffic. Although no classifictaion data is available, it is assumed that RV's and motorcycles constitute a slightly larger share of the total traffic during the summer months.

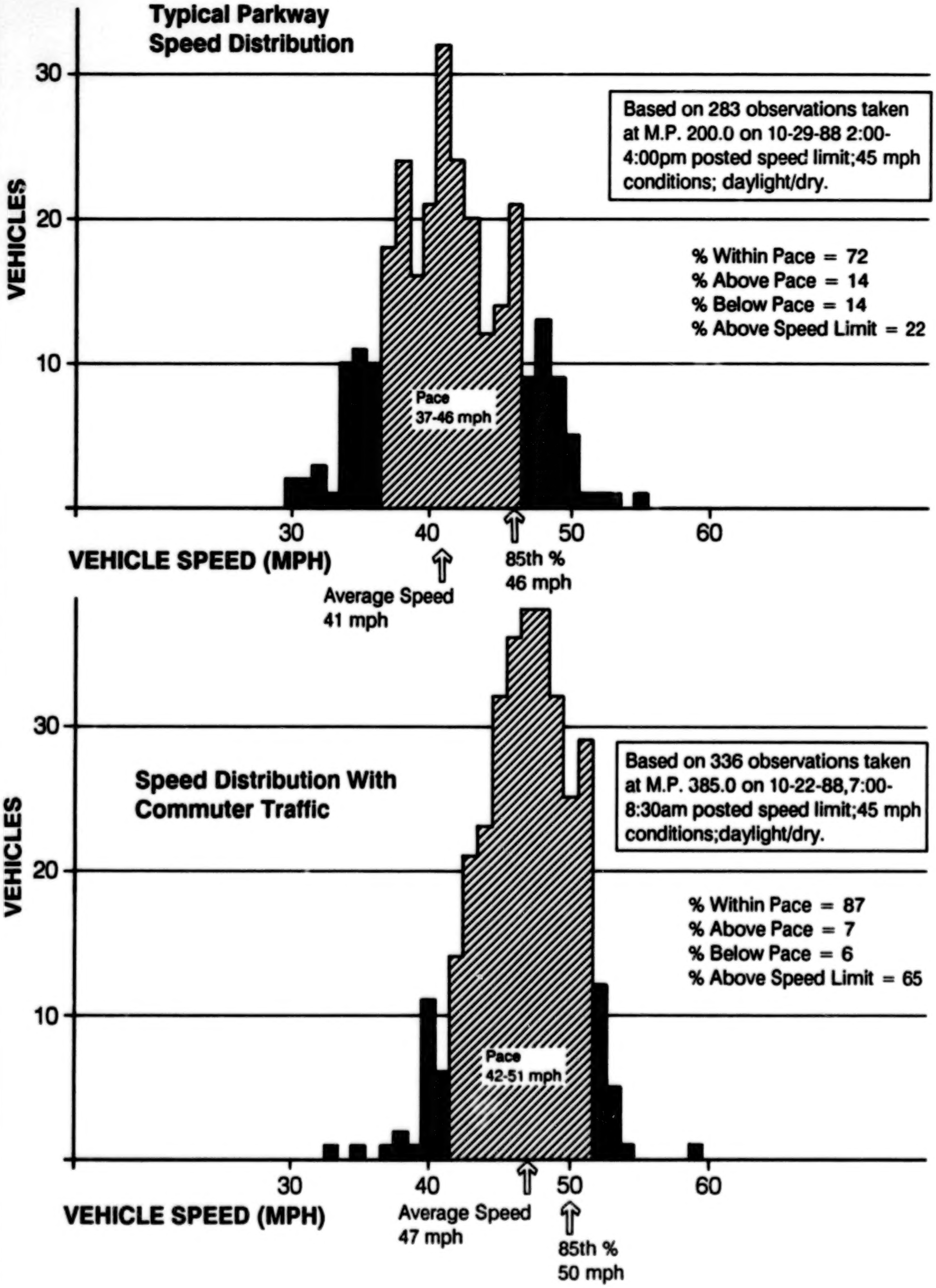
E. Vehicle Speeds

Vehicle speed studies are designed to measure the speed characteristics of the traffic at a particular location. Travel speed is an important consideration because it relates safety, time, and quality of travel to the motorists using a roadway. Vehicle speeds were recorded with radar equipment at 23 locations on the Parkway where at least 30 vehicles in each travel direction were observed during each speed test.

The data obtained from each spot speed study was used to identify several important characteristics of travel speeds on the Parkway including the pace, average travel speed, the 85th percentile speed, and the percentage of vehicles exceeding the posted speed limit. The pace refers to the ten-mile per hour range of speeds which contains the largest number of observations. A normal speed distribution will have approximately 70% of the sample within the pace, with 15% of the sample above and below it. As the percentage of vehicles within the pace increases, the frequency of passing is reduced thereby minimizing the potential for conflicts. The 85th percentile speed is the speed at or below which 85% of the traffic is moving. This speed is most indicative of a safe and reasonable speed limit. The average speed of the total sample is always within the pace while the 85th percentile speed is usually within two miles per hour of the upper limit of the pace.

Figure 7 depicts a speed distribution for a typical Parkway road segment and shows the resulting speed distribution where commuter traffic exists. A comparison of the two graphs reveals the difference between the typical Parkway traffic and commuter traffic. Although 65% of the commuter traffic is exceeding the speed limit, 87% of the sample is within the pace. This speed distribution is a relatively safe condition due to fairly consistent travel speeds by commuters.

A speed test was performed at the Peaks of Otter (MP 86.0) where a reduced speed zone exists. Although the posted speed limit is 35 mph at this location, the average speed is 38 mph. The pace contained only 57% of the total sample with 26% above the pace. The results also show that 68% of the traffic exceeded the speed limit at this site. A similar test was conducted at Craggy Gardens (MP 364.6), an area within a 25-mph reduced speed zone. The average speed at this site was 35 mph with 60% of the sample within the pace and 26% above the pace. All of the vehicles observed in this test sample exceeded the 25-mph speed limit. These tests indicate that lower speed zones achieve a reduction in the average speed, but they do not yield the complete result desired. Most motorists exceed the posted speed limit in these areas. Speeding can be reduced by better sign placement and increased visibility of Parkway Rangers. In most cases shortening the length of the speed zone will increase its effectiveness. The reduced speed limit signs should be placed approximately 500 feet in advance of the developed area.



Typical Parkway Speed Distribution

Based on 283 observations taken at M.P. 200.0 on 10-29-88 2:00-4:00pm posted speed limit;45 mph conditions; daylight/dry.

% Within Pace = 72
% Above Pace = 14
% Below Pace = 14
% Above Speed Limit = 22

Average Speed 41 mph

85th % 46 mph

Speed Distribution With Commuter Traffic

Based on 336 observations taken at M.P. 385.0 on 10-22-88,7:00-8:30am posted speed limit;45 mph conditions;daylight/dry.

% Within Pace = 87
% Above Pace = 7
% Below Pace = 6
% Above Speed Limit = 65

Average Speed 47 mph

85th % 50 mph

Figure 7
Typical Speed Distribution

Three speed tests were conducted at locations where advisory speeds have been posted (MP 37.4, 90.8, and 205.8). The study results indicate a slight reduction in the pace with at least 65% of the sample remaining within the pace limits. Based on this data, it appears the advisory speed signing at these locations has produced the desired results--a lowering of vehicle speeds without significant disruption of the overall speed distribution.

A summary of the vehicle speed studies is presented in Table 3. It was concluded from this data that the current speed limit of 45 mph is appropriate for the Parkway. The data also indicates that a significant percentage of Parkway traffic exceeds the posted speed limit. An effective way to reduce Parkway speeding would be to increase the visibility of Parkway Rangers.

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Table 3
Speed Study Summary

Milepost	Date	Posted Speed Limit	Pace	Percent Within Pace	Percent Above Pace	Percent Below Pace	Average Speed	85th Percentile Speed	Percent Over Speed Limit
37.4	11/09/88	30*	33-42	67	8	25	37	41	79#
86.0	11/07/88	35	33-41	57	26	17	38	46	68
90.8	11/08/88	35*	30-39	67	19	14	35	41	48#
118.5	11/07/88	45	45-54	86	11	3	49	54	92
120.0	11/06/88	45	45-54	71	7	22	48	52	72
121.0	11/05/88	45	42-51	67	8	25	45	50	47
121.2	11/06/88	45	39-48	63	14	23	42	48	28
128.2	11/06/88	45	43-54	61	9	30	46	51	52
199.3	10/30/88	45	35-44	58	16	26	38	45	11
200.0	10/29/88	45	37-46	72	14	14	41	46	22
205.8	10/29/88	35*	36-47	65	20	15	41	47	20#
217.2	10/29/88	45	40-49	64	20	12	45	51	42
287.1	10/27/88	45	49-58	56	15	29	52	59	75
290.9	10/26/88	45	53-52	56	16	28	46	53	52
291.5	10/25/88	45	41-50	58	15	27	45	50	43
292.0	10/25/88	45	38-47	58	26	16	44	50	39
364.6	04/02/89	25	30-39	60	26	14	35	42	100
382.0	10/24/88	45	38-47	72	12	16	40	47	24
384.6	10/22/88	45	39-48	63	23	14	45	51	45
385.0	10/22/88	45	42-51	87	6	7	47	50	65
385.2	10/22/88	45	38-47	73	22	5	45	59	40
388.0	10/22/88	45	44-53	77	11	12	49	53	76
451.5	10/23/88	45	37-46	63	19	18	41	47	25

* Posted advisory speed.
# Percent over posted advisory speed.

Chapter IV: Accident Analysis

A. General

An accident analysis was conducted to identify trends and patterns which may be indicative of traffic safety problems on the Parkway. The accident investigation consisted of a review of all reported motor vehicle accidents that occurred during a four-year period from January 1, 1984 through December 31, 1987. The accident report and supplemental information for each incident that occurred during this period was obtained from Parkway Headquarters in Asheville, North Carolina. These records were reviewed and all pertinent information was entered into a computer database. This database, together with traffic volume data, provided the basic information used to calculate accident rates and to perform various analyses. Current Parkway accident investigation and reporting procedures were also examined as part of this analysis.

B. Accident Record System

The NPS rangers have the primary responsibility for law enforcement and accident investigation on the Blue Ridge Parkway. State and county law enforcement agencies have concurrent jurisdiction and provide assistance upon request or if they are first to encounter an accident scene. All accidents on the Parkway road system and in developed areas are investigated and reported by the NPS. Traffic accident investigations are conducted at the scene where information is gathered and later transferred to a final, typed report. The accident reports are reviewed by the District Ranger and then sent to the Chief Ranger's Office where the accident information is entered into a computer database. This computerized recordkeeping system is used as the source for Parkway accident statistics. The hard copy of the records are kept on file at Parkway Headquarters.

The data collected during the investigation and transferred to the accident record includes information on the drivers, passengers, and vehicles involved; accident type, cause, and severity; date, time, and location of the accident; road and weather conditions; driver and witness statements; accident sketch and photographs; and a statement from the investigating officer.

Additional investigations and reviews are held for all accidents involving a death or severe injury and any incidents involving Parkway personnel or NPS vehicles.

C. Summary of Study Period Accidents

A total of 1,499 accidents were reported on the Blue Ridge Parkway during the four-year study period. There were 24 fatality accidents that caused 31 deaths and 18 injuries; 453 injury accidents with 655 injuries; and 1,022 property-damage-only accidents. Table 4 details the accident severity statistics for each year of the study period.

Table 4
Accident Severity Summary

	1984	1985	1986	1987	Total
Number of Accidents	337	330	395	437	1,499
Number of Fatality Accidents	7	5	9	3	24
Number of Fatalities	9	7	12	3	31
Number of Injuries in Fatality Accidents	5	2	4	7	18
Number of Injury Accidents	114	109	115	115	453
Number of Injuries	174	155	167	159	655
Property-Damage-Only Accidents	216	216	271	319	1,022

A review of the fatality accidents indicated that they typically involved a single vehicle and occurred during clear weather conditions on dry pavement. The records also showed that excessive speed was a factor in most fatality accidents.

Single-vehicle accidents accounted for 1,178 of the 1,499 accidents that occurred on the Parkway during the study period. Accidents which involved 2 vehicles or 3 or more vehicles totalled 299 and 22, respectively, of all accidents on the Parkway during the 4-year period. One hundred ninety-seven accidents occurred within one-tenth of a mile of a major Parkway intersection, and 145 accidents occurred within one-tenth of a mile of a Parkway developed area.

A map showing the location of all accidents that occurred during the study period is presented in Figure 8. The location of all fatality, injury, and animal-vehicle accidents have been identified in the figure to aid in the interpretation of the data.

D. Accident Rates For The Blue Ridge Parkway

Accident rates provide the most useful method of analyzing data and comparing the hazardousness of different road systems. Accident rates for roads are typically expressed in terms of accidents per million vehicle miles traveled (ACC/MVMT). The number of vehicle miles traveled on the Parkway was calculated by multiplying seasonally-adjusted traffic counts by the lengths of specific road segments. The calculations used 1988 traffic counts, and the results were adjusted using annual visitation records to estimate the total vehicle miles traveled during the 4-year study period. Based on these calculations, it was estimated that 180.1972 MVMT occurred on the Parkway in 1988 and 598.7852 MVMT occurred during the 1984 through 1987 period.

A comparison of the number of accidents to the total vehicle miles traveled during the study period indicates an overall accident rate of 2.50 ACC/MVMT for the Blue Ridge Parkway. The National Park Service (Denver Service Center) has calculated various statistics from historical accident and traffic volume data at 10 national parks. Vehicle use of these park roads comprise approximately 60% of all vehicle miles traveled on rural park

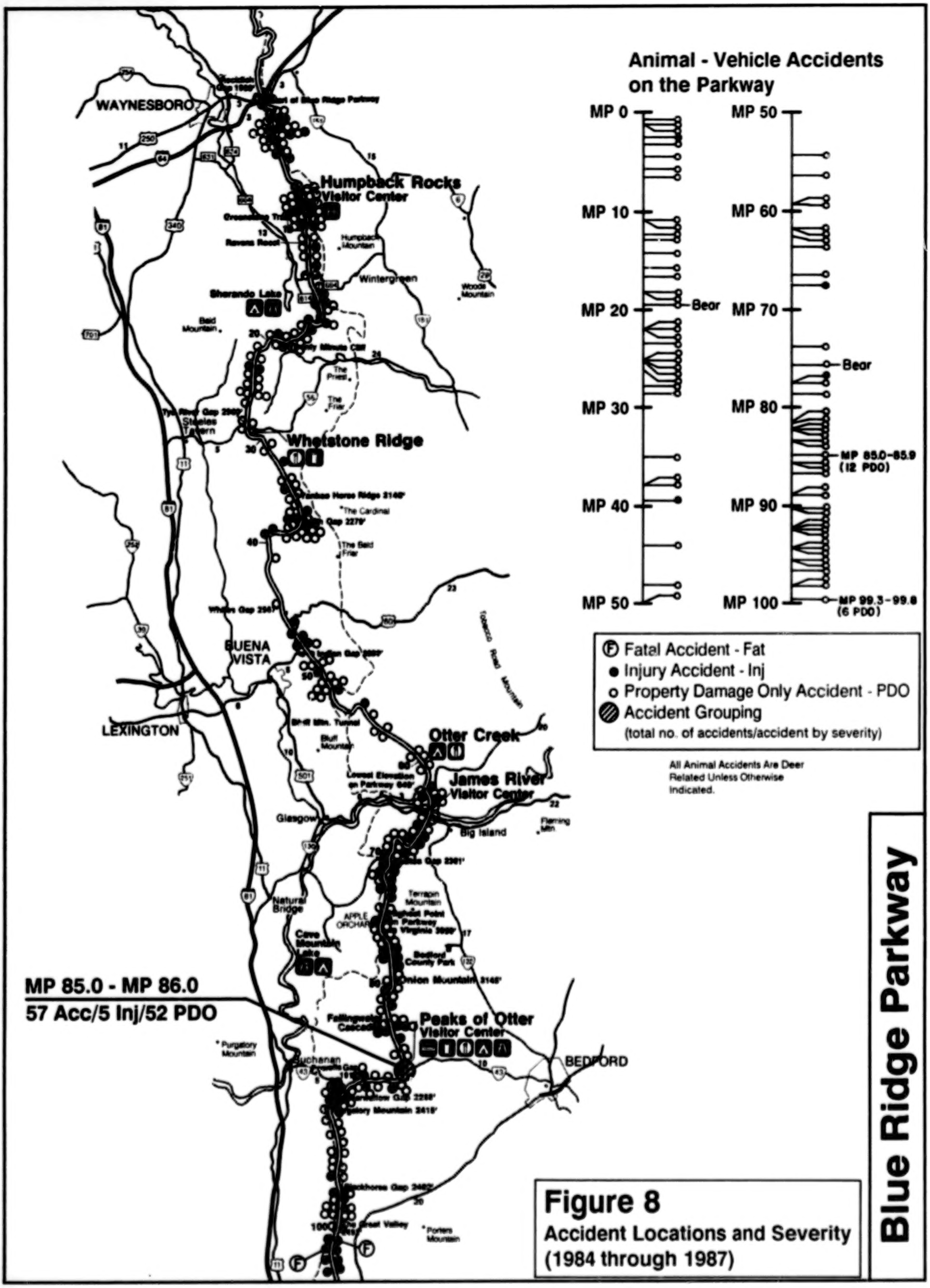


Figure 8
Accident Locations and Severity (1984 through 1987)

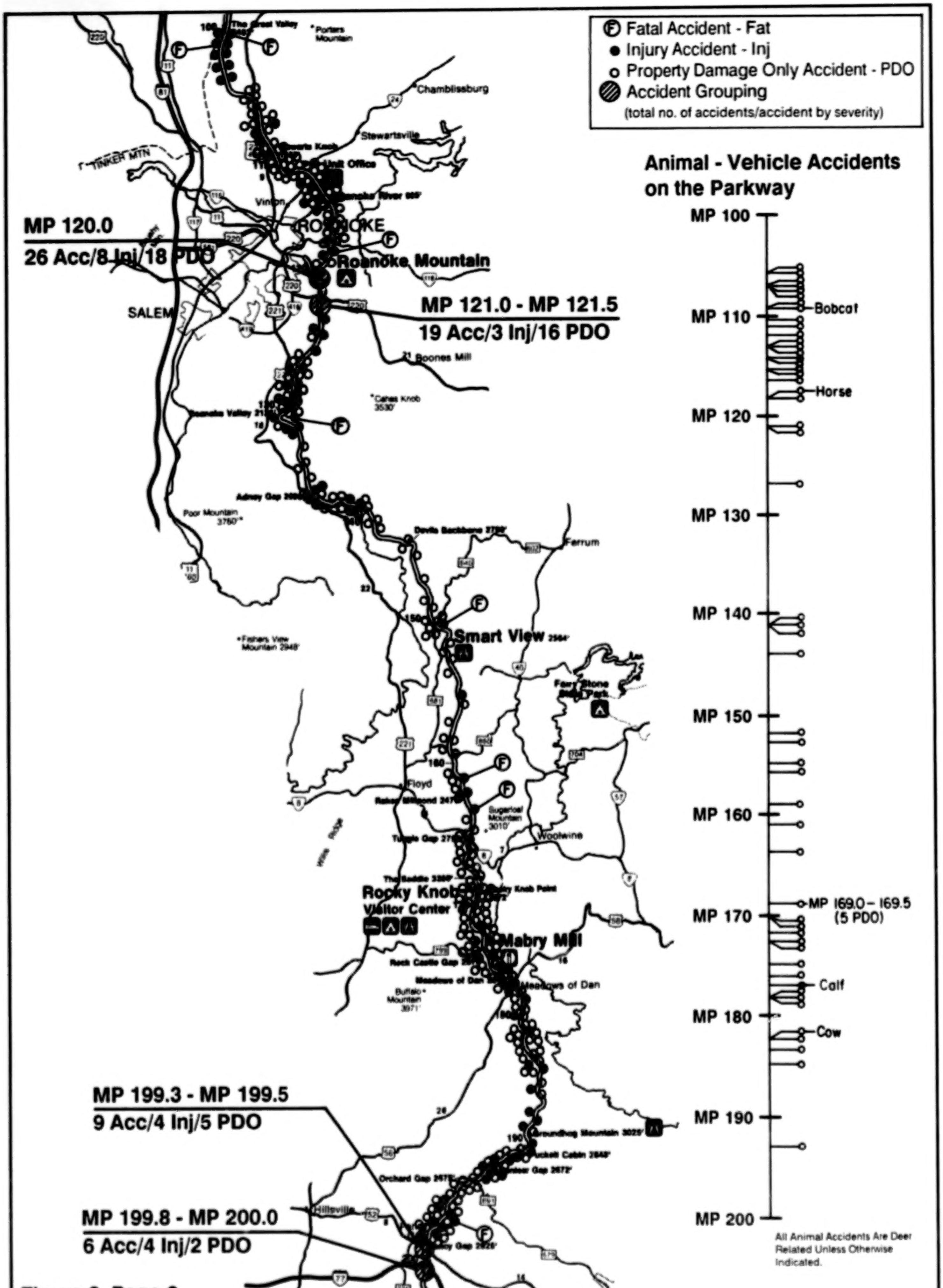
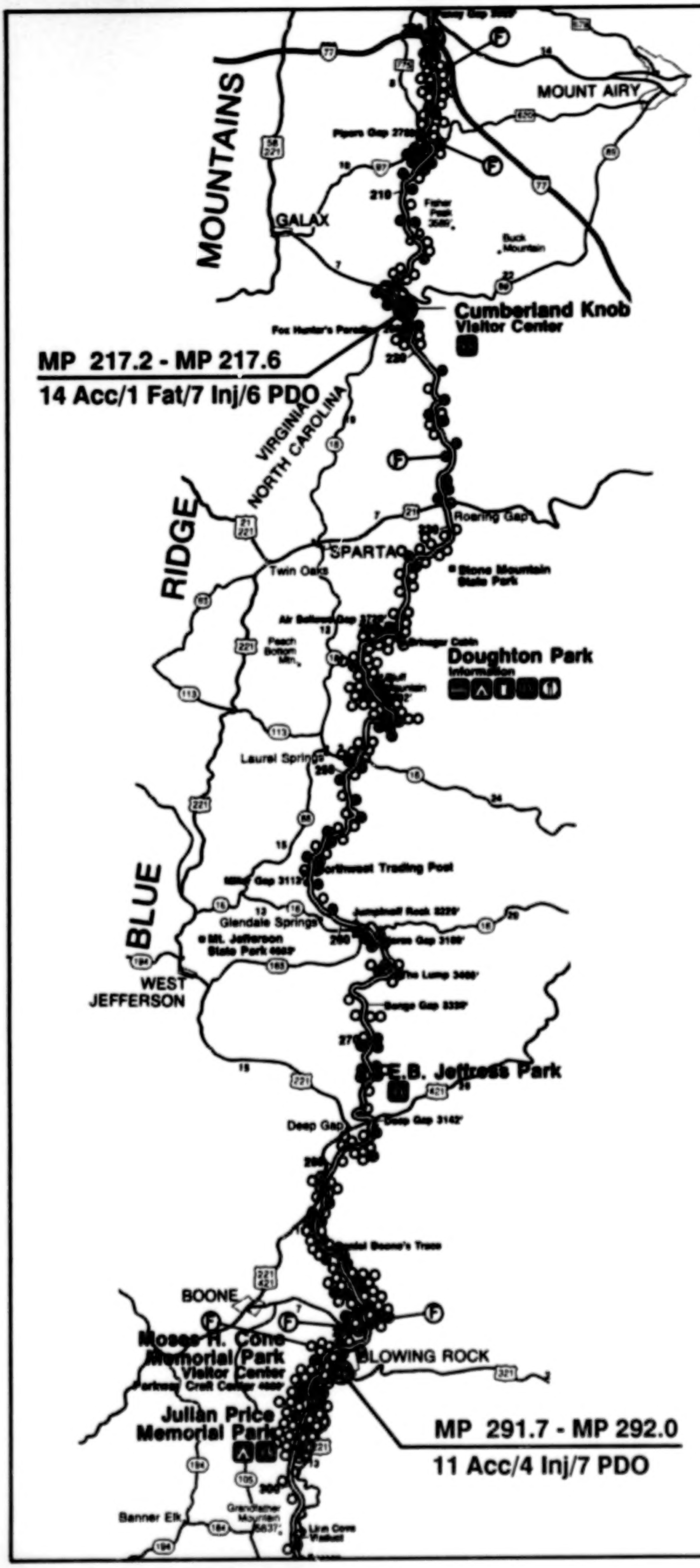
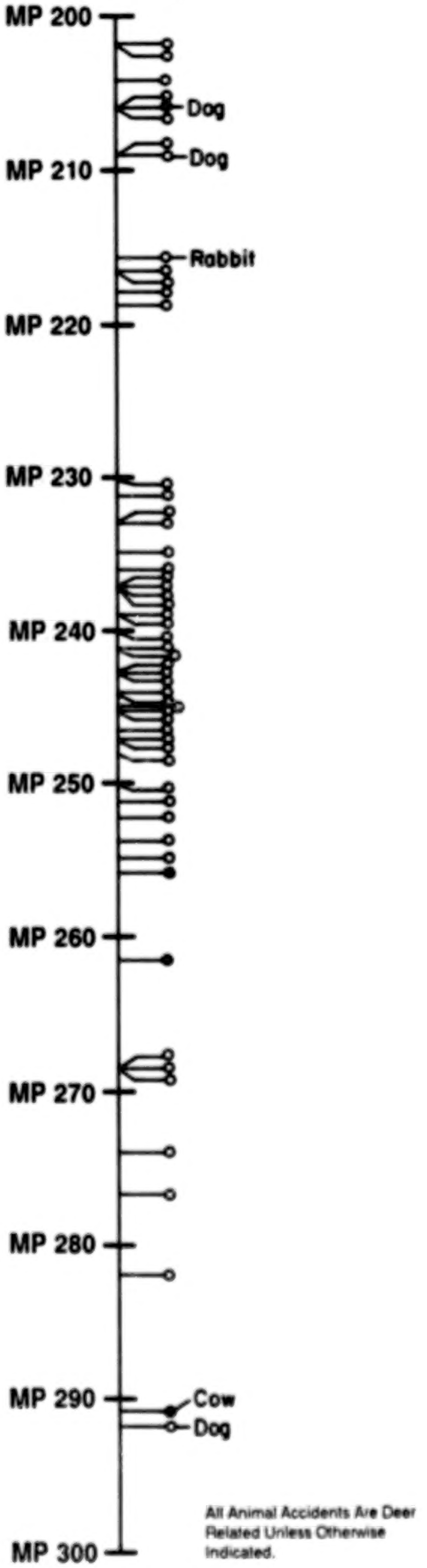


Figure 8 Page 2



Ⓕ Fatal Accident - Fat
● Injury Accident - Inj
○ Property Damage Only Accident - PDO
▨ Accident Grouping
(total no. of accidents/accident by severity)

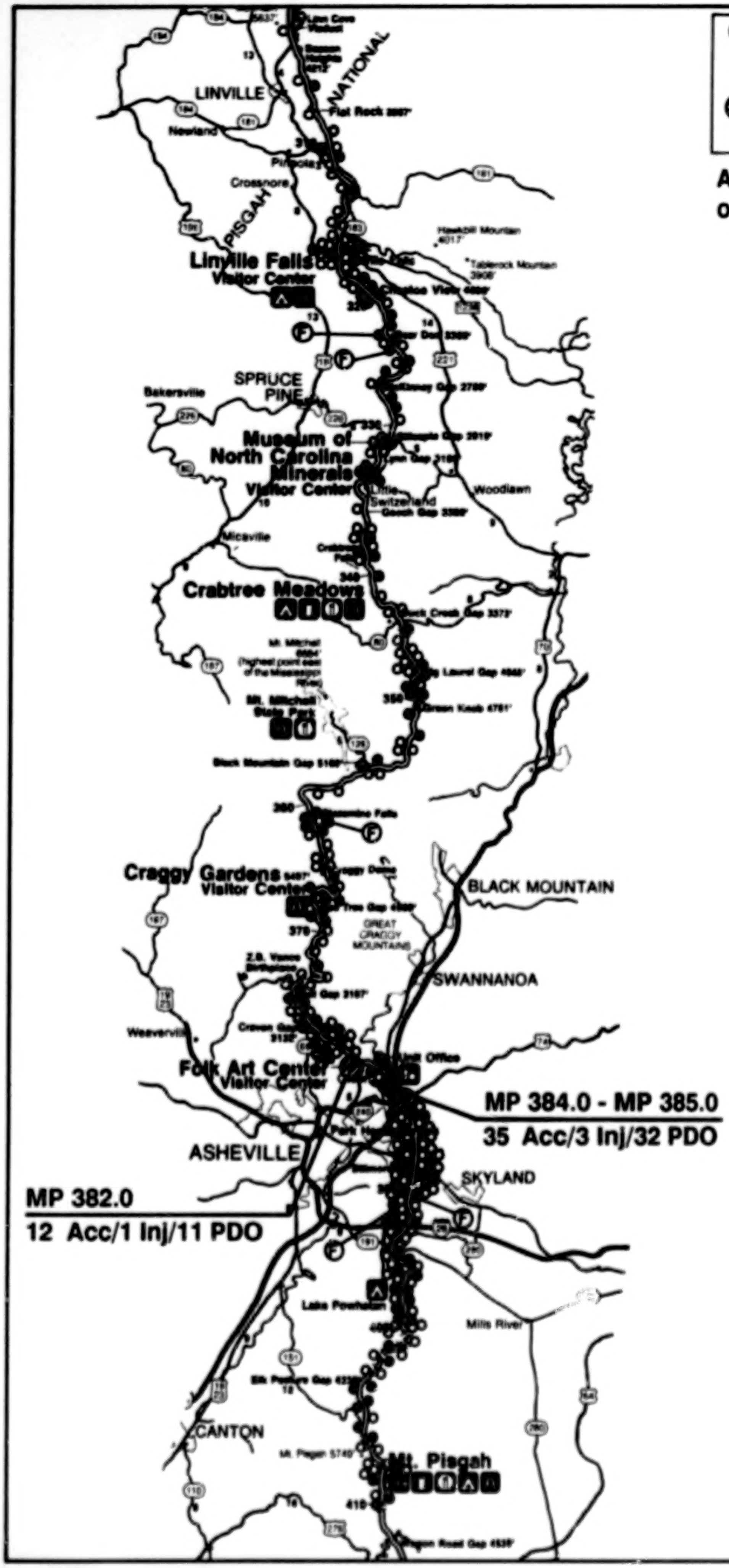
Animal - Vehicle Accidents on the Parkway



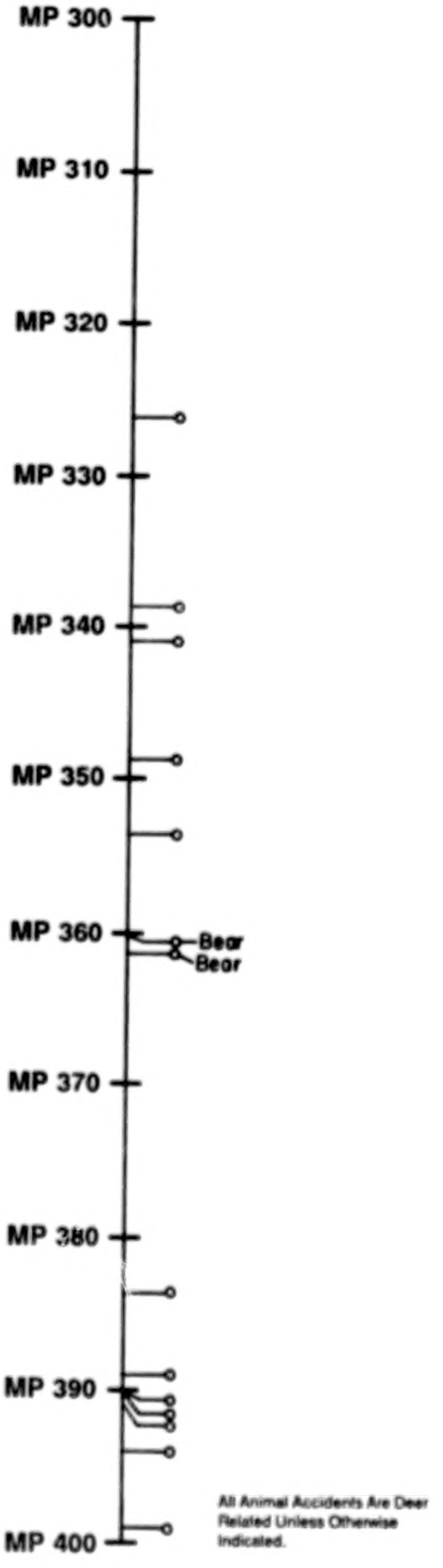
All Animal Accidents Are Deer Related Unless Otherwise Indicated.

Figure 8 Page 3

Ⓕ Fatal Accident - Fat
● Injury Accident - Inj
○ Property Damage Only Accident - PDO
▨ Accident Grouping
(total no. of accidents/accident by severity)

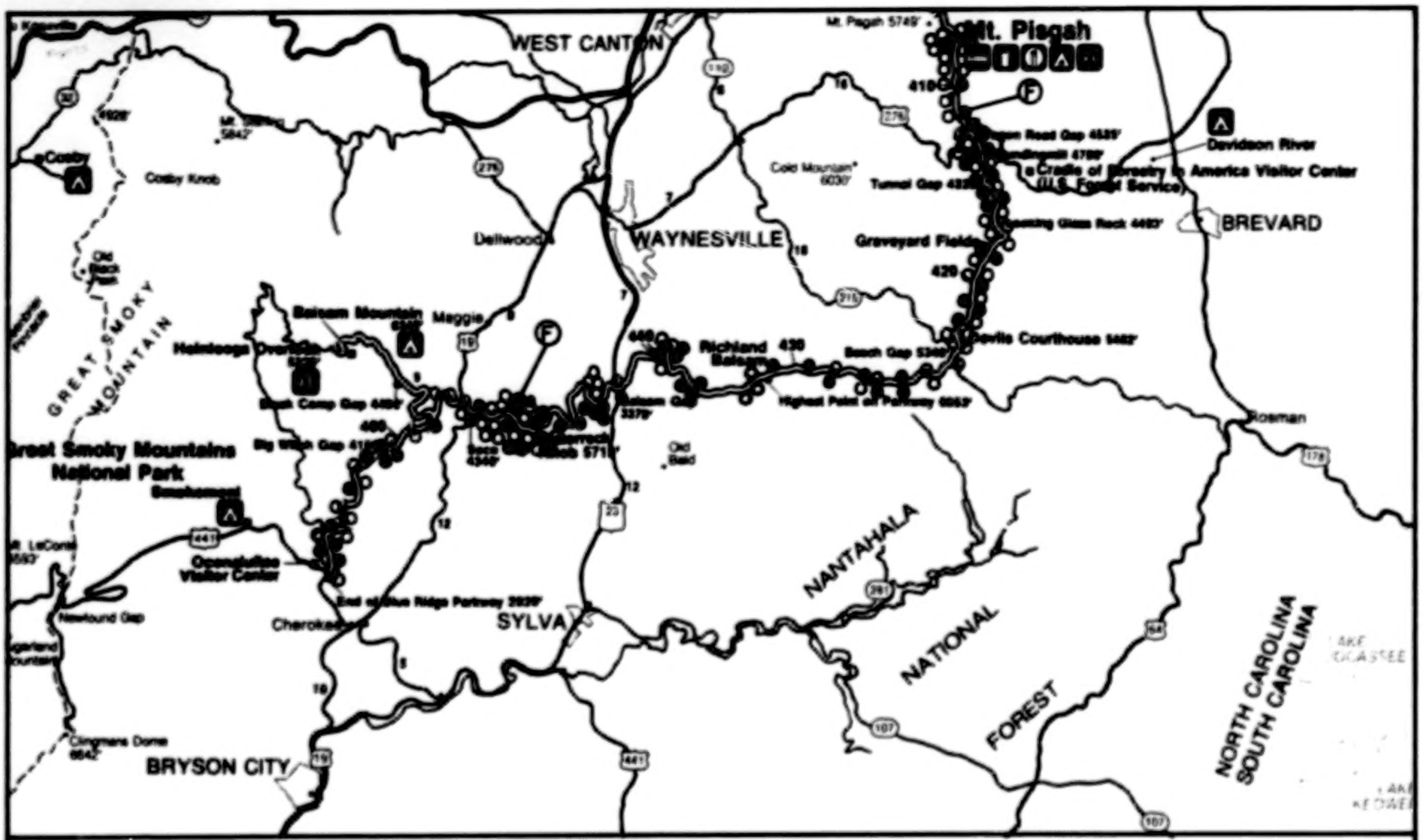


Animal - Vehicle Accidents on the Parkway



All Animal Accidents Are Deer Related Unless Otherwise Indicated.

Figure 8 Page 4



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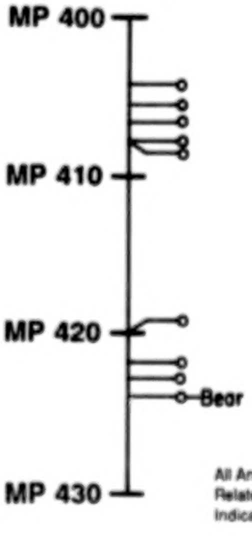
(total no. of accidents/accident by severity)

Animal - Vehicle Accidents on the Parkway



All Animal Accidents Are Deer Related Unless Otherwise Indicated.

roads. Separate accident rate statistics have also been developed for the Great Smokey Mountains National Park, Shenandoah National Park, and the Natchez Trace Parkway. The accident rates developed by the NPS for selected units of the National Park System are presented in Table 5.

Table 5
Accident Rates on NPS Road Systems

Location	Total Accident Rate (ACC/MVMT)	Injury Accident Rate (ACC/100 MVMT)	Fatality Accident Rate (ACC/100 MVMT)
10-Park Average[1]	3.33	68.18	3.17
Shenandoah National Park[2]	7.64	64.69	2.94
Great Smoky Mountain National Park[3]	3.51	67.95	2.56
Natchez Trace Parkway[4]	1.22	32.20	3.58
Blue Ridge Parkway	**2.50**	**76.81**	**4.00**

Transportation officials in Virginia and North Carolina were contacted to obtain accident rates for various road classifications in an effort to compare the Parkway's accident rate with accident rates of other road systems. This data is presented below in Table 6.

Table 6
Vehicle Accident Rates of Various Highways

Type of Highway	Accident Rate (ACC/MVMT)
Virginia Interstate[5]	0.83
Virginia Primary (2-lane)[5]	1.70
Virginia Secondary[5]	3.89
North Carolina - All Public Roads[6]	3.16
Blue Ridge Parkway	**2.50**

Accident rates also define the relative severity of accidents that occur on different road systems. The most common accident severity rates are death and injury rates which relate the number of fatalities or injuries to the amount of vehicle miles traveled. The death rate on the Blue Ridge Parkway was determined to be 5.18 deaths/100 MVMT. The injury rate on the Parkway is 112.39 injuries/100 MVMT. Several information sources were examined to compare the accident severity rates of the Blue Ridge Parkway with state highways and other roads on the NPS system. These rates are shown in Table 7.

Table 7
Accident Severity Rates of Various Highways

Type of Highway	Death Rate (per 100 MVMT)	Injury Rate (per 100 MVMT)
Nationwide Rural Interstate[7]	1.44	39.27
Nationwide Rural Primary[7]	3.64	118.15
Nationwide Rural Secondary[7]	4.15	154.60
Virginia Interstate[5]	0.7	46.00
Virginia Primary (2-lane)[5]	3.5	112.00
Virginia Secondary[5]	3.0	213.00
North Carolina - All Public Roads[6]	2.93	210.00
Shenandoah National Park[2]	2.94	144.07
Great Smoky Mountains National Park[3]	2.56	112.51
Natchez Trace Parkway[8]	4.03	48.06
Blue Ridge Parkway	**5.18**	**112.39**

Based on information presented in the preceding tables, it is apparent that the overall accident rate for the Blue Ridge Parkway is rather low compared to other roads. It is suspected that the Parkway's low overall accident rate may be due to the fact that many property-damage-only are unreported. Field observations of skid marks, disrupted shoulders, and tree damage and a lack of accident reports for such locations suggest that motorists may leave the accident scene without reporting the incident. The severity of the accidents on the Parkway is significant as evidenced by a death rate that is substantially higher than the other roads evaluated for this study. The injury accident rate for the Parkway is not significantly different than those for other NPS or state roads.

E. Analysis Of Study-Period Accidents

1. Nighttime Accidents

A total of 592 (39.5%) of the 1,499 reported accidents happened either at night, dawn or dusk. It is necessary to identify the amount of travel during low-light conditions to better understand the frequency of these accidents. Estimates of the number of hours between dusk and dawn and the volume of traffic using the Parkway during these hours was calculated for each month from the NPS's permanent traffic count data. Based on these estimates, it was determined that low-light conditions occur about 52% of the time and that 18% of all Parkway travel occurs during this period. Subsequent analyses determined that the nighttime accident rate is 5.49 ACC/MVMT and the daytime rate is 1.85 ACC/MVMT. A comparison of nighttime to daytime accident rates on the Parkway results in a ratio of approximately 3:1. Studies performed by the Federal Highway Administration (FHWA) indicate nighttime accident rates for all types of roads are typically 3.4 times higher than the corresponding daytime rates[9].

The nighttime accidents on the Parkway resulted in 50% of all fatality accidents and 31% of all injury accidents that occurred during the study period. Ninety-four percent of all low-light condition accidents involved a single vehicle.

2. Animal/Vehicle Accidents

A total of 229 animal/vehicle accidents occurred during the 4-year study period. This represented approximately 15% of all Parkway accidents and 27% of all nighttime accidents in the period. An analysis revealed that deer were involved in 214 cases and that 70% of all animal/vehicle collisions occurred in low-light conditions (dusk, dawn, or night). Only 10 of the animal/ vehicle accidents resulted in injuries to vehicle occupants.

Driver statements included in the NPS accident forms indicate that numerous accidents, in which an animal collision did not occur, were actually caused by animals on the Parkway. Therefore, the true number of animal-related accidents is higher than the 229 cases identified in this analysis.

The location of each animal/vehicle accident is presented in Figure 8. Interpretation of this data shows that 86% of these accidents occurred between MP 0 and 256, and only 14% of the animal/vehicle accidents occurred between MP 256 and the southern Parkway terminus. The greatest concentration of animal/vehicle accidents occurred between MP 80 and 100 (43 acc) and MP 130 and 148 (26 acc).

3. Wet-Road Accidents

A total of 236 wet-road accidents occurred during the study period. Seven deaths and 111 injuries were recorded in the 4 fatal and 70 injury accidents that occurred on wet roads. Eighty-two percent of these accidents involved only one vehicle.

Wet-road accidents accounted for approximately 16% of all Parkway accidents. These accidents occurred throughout the year and at random locations. The only clusters of wet-road accidents were between MP 83 and 88 near the Peaks of Otter (16 accidents) and between MP 380 and 389 in the Asheville area (16 accidents). Forty-seven percent of the wet-road accidents during the 4-year study period happened at night.

4. Snowy or Icy-Road Accidents

Accidents that occurred when snow or ice was on the Parkway accounted for 236 or 16% of the 1,499 cases included in this analysis. Eighty-five percent of these incidents involved a single vehicle, and most were significantly less severe than the wet-road accidents. Snowy or icy-road conditions produced 2 fatality and 41 injury accidents causing 2 deaths and 48 injuries.

Although snow or icy road accidents were reported over the entire length of the Parkway, 50% of such accidents occurred in three specific areas. These high frequency areas, accounting for 52 miles of the Parkway, were located at MP 170 to 201 (50 acc), MP 280 to 297 (48 acc), and MP 384 to 388 (20 acc). Forty-six percent of the accidents during snow or icy-road conditions occurred at night.

The seasonal variation in the numbers of accidents and accident rates on the Parkway is shown in Figure 9. Summer and fall months had the highest numbers of accidents but relatively low accident rates (1.8 to 2.6 ACC/MVMT). Note that the accident rates for the months of December, January, and February are significantly higher than the other 9 months with rates ranging from 3.38 to 5.35 ACC/MVMT. Eighty-three percent of all snowy or icy-road accidents occurred during the months of December, January, and February which represented 65% of all accidents in this 3-month period.

5. Accidents During Foggy Conditions

A total of 114 motor vehicle accidents occurred during foggy conditions. Fifty percent of these accidents happened in the months of September, October, and November. Fog-related accidents resulted in 27 injury accidents, with a total 45 injuries. There were no fatal accidents recorded during foggy weather. Eighty-two percent of all fog-related accidents involved single vehicles, and 54% occurred at night.

Although fog-related accidents occurred at various locations, 31% happened in three areas, representing 50 miles of Parkway. These high frequency areas were MP 83 to 100 (13 acc), MP 192 to 200 (9 acc), and MP 269 to 296 (13 acc).

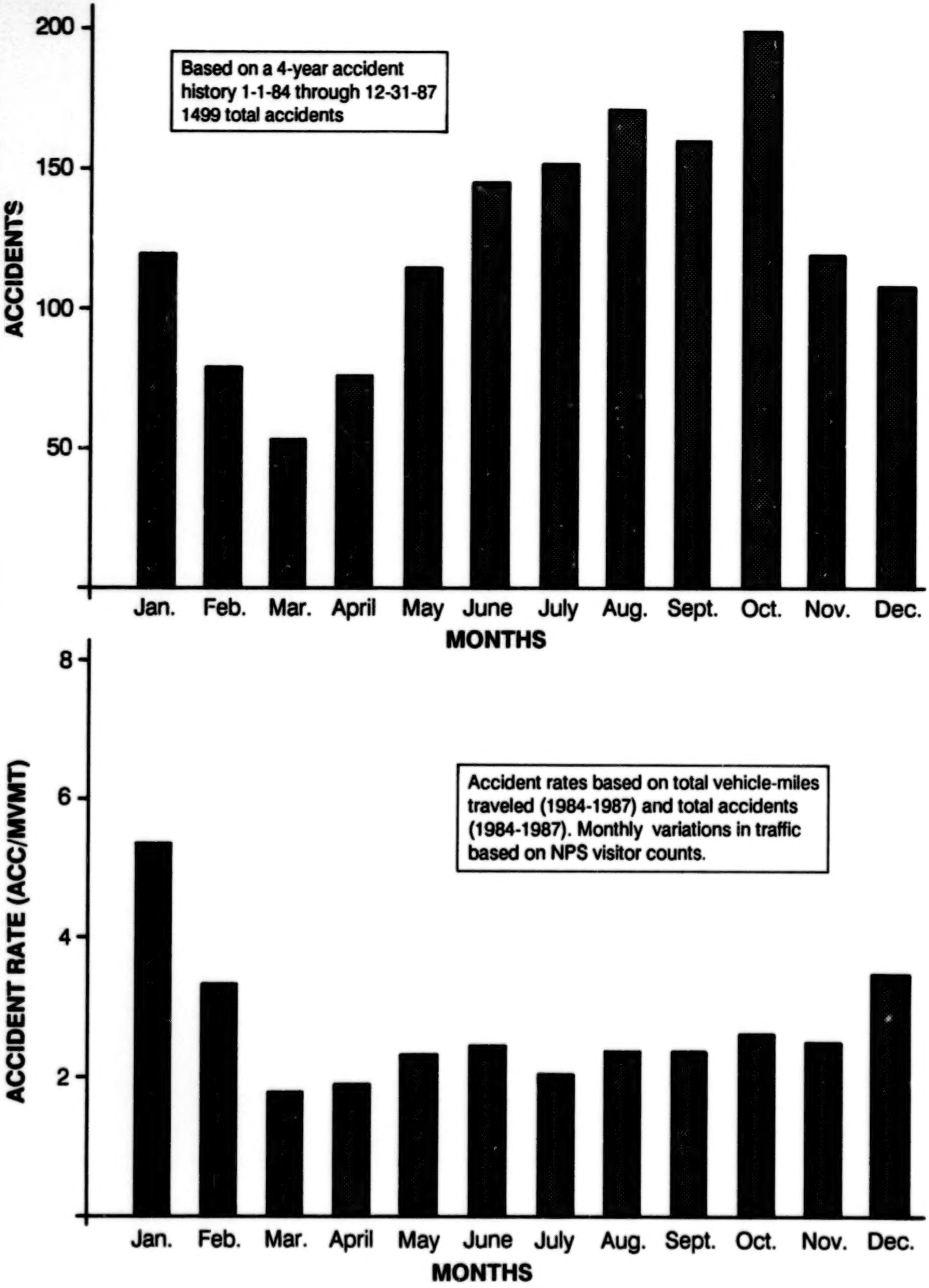
6. Fixed-Object Accidents

This analysis included an examination of objects that were struck as a result of a vehicle leaving the roadway. Accidents involving collisions with fixed-objects accounted for 691 (46%) of the 1,499 accidents recorded in the study period. The fixed-objects most frequently struck are listed below:

Object Struck	No. of Accidents
Earth Embankment	250
Tree	142
Guide Rail	71
Rock Outcropping	42
Drainage Ditch	25
Fence	22
Curb or Median	19
Rock Wall	19
Sign	18
Barricade Gate	16
Bridge or Bridge End	16
Shrub	15
Culvert	14

7. Roll-over Accidents

There were 174 cases where vehicles rolled over during accidents on the Parkway. This represented 11.5% of all accidents that were recorded during the study period. These roll-overs accounted for 14 fatality and 85 injury accidents and produced 17 deaths and 144



Based on a 4-year accident history 1-1-84 through 12-31-87 1499 total accidents

Accident rates based on total vehicle-miles traveled (1984-1987) and total accidents (1984-1987). Monthly variations in traffic based on NPS visitor counts.

Figure 9

Seasonal Variations in the Number of Accidents and Accident Rates

Blue Ridge Parkway

injuries. Alcohol was involved in 37 of the 174 (22.4%) roll-over accidents. A review of the accident records indicate that high speeds and the vehicle leaving the paved surface were the most common factors in roll-over accidents.

8. Tunnel Accidents

Four accidents occurred at tunnels on the Parkway during the study period. Accidents were reported at North Twin, Fork Mountain, Frying Pan, and Rattlesnake Mountain Tunnels. Vehicles collided with tunnel walls in two instances and the face of the tunnel entrance in one other accident. Only one of the tunnel-related accidents involved a collision between vehicles. Wet or snow-covered pavement was a factor in three of the four accidents. All accidents happened during the day suggesting that the change in light conditions upon entering the tunnel may have been a contributing factor. No pedestrians or bicyclists were involved in any of the accidents at Parkway tunnels.

9. Pedestrian and Bicycle Accidents

There were 14 bicycle/vehicle accidents which resulted in one death and 15 injuries recorded during the four-year study period. The typical bicycle/vehicle incident involved a bicyclist on the Parkway being sideswiped by a passing vehicle. All bicycle-vehicle accidents occurred during the day on dry pavement.

Three pedestrian/vehicle accidents resulting in one death and three injuries were reported during the period. The fatal pedestrian accident occurred at night on icy pavement. All other pedestrian-related accidents occurred during the day on dry pavement.

10. Accidents in Developed Areas

A total of 145 accidents occurred within one-tenth of a mile of a major developed area. The highest number of accidents occurred near the following developed areas:

Developed Area	No. of Accidents
Peaks of Otter	50
Roanoke Mountain-Mill Mountain Road	25
Folk Art Center	12
Mt. Pisgah	9
Julian Price Memorial Park	9
Rocky Knob	8
Moses H. Cone Memorial Park	8

The majority of these accidents were fixed-object collisions in campgrounds or parking areas or collisions with parked vehicles. It should be noted that the current NPS accident recording system does not clearly identify the location of developed area accidents. It is common practice to reference the accident to the nearest milepost on the adjacent Parkway. This referencing method makes it difficult to identify where an accident occurred within a developed area. NPS recently revised their accident reporting form to include a link-node network referencing system. The link-node network includes Park side roads and roads within developed areas. This new system, when fully implemented, will enable reporting officers to accurately define the location of an accident.

11. Alcohol/Drug-Related Accidents

Alcohol or drugs were involved in 110 of the 1,499 accidents reported on the Parkway during the study period. The 13 fatality and 50 injury accidents in which these substances were involved produced 17 deaths and 92 injuries. Seventy-eight of these accidents occurred at dusk or night. Based on the accident records, driving under the influence was a contributing factor in 7.3% of all reported accidents on the Parkway. Further analysis revealed that alcohol was a factor in 54% of all fatality accidents, 11% of all injury accidents, and 4% of all property-damage-only accidents. Discussions with NPS rangers indicate that alcohol involvement in motor vehicle accidents may be substantially higher. Rangers suspect that many nighttime run-off-the-road accidents and animal/vehicle accidents go unreported until the following day, providing the driver time to recover from the effects of the drinking during the previous night.

12. Motorcycle Accidents

Based on the results of the vehicle classification study presented previously, motorcycles represent only 1% of the total number of vehicles on the Parkway. However, motorcycles were involved in 227 accidents during the study period which accounted for 15% of all Parkway accidents. The 6 fatality and 160 injury accidents in which motorcycles were involved resulted in 8 deaths and 187 injuries. Motorcycle accidents represented 25% of all fatality accidents and 34% of all injury accidents on the Blue Ridge Parkway in the 4-year study period. Most motorcycle accidents occurred during the day on dry pavement.

It is interesting to compare the Parkway's motorcycle accident history with nationwide statistics. According to a 9-state study conducted by the National Safety Council in 1987, motorcycle accidents typically comprise only 1.1% of all accidents and 6.6% of all fatal accidents[10]. It is evident from these statistics that motorcycle accidents occur more frequently and are more severe on the Blue Ridge Parkway than on other road systems.

References

1. Jim Straughan, Chief, Branch of Transportation, NPS, Denver Service Center, personal communication, April, 1989.

2. Calculation by Robert Peccia & Associates, accident data from Glenn Knight, Shenandoah National Park (1987 data).

3. Calculation by Robert Peccia & Associates, accident data from Bob Whiteman, Great Smoky Mountains National Park (1987 data).

4. Traffic Safety Study, Natchez Trace Parkway, Robert Peccia & Associates, Helena, MT, September, 1987, p. 53 (1982-1986 data).

5. Gerald Venable, Traffic Division, Virginia Department of Transportation, personal communication (1987 data).

6. North Carolina Accident Fact Book, 1987 edition, North Carolina Department of Transportation (Twenty-year average of all roads in North Carolina).

7. Accident Facts, 1986 Edition, National Safety Council (1984 data).

8. Calculations by Robert Peccia & Associates, accident data from Traffic Safety Study, Natchez Trace Parkway, Robert Peccia & Associates, Helena, MT, September, 1987 (1982-1986 data).

9. "Synthesis of Safety Research Related to Traffic Control and Roadway Elements", Vol. 2, Federal Highway Administration, FHWA-TS-82-233, December 1981, p. 12-2.

10. Accident facts, 1988 edition, National Safety Council, p. 60.

Chapter V: Systemwide Traffic Safety Deficiencies and Recommendations

A. General

This chapter includes an examination of systemwide traffic safety problems and deficiencies. These deficiencies were identified through detailed accident analyses and through field observations of the design, maintenance, and operation of the Parkway. This chapter presents recommendations that address the deficiencies identified during this study and are based on commonly accepted traffic-safety guidelines and practices.

B. Problems Identified through Accident Analyses

1. Accident Reporting and Filing System

Several deficiencies relating to accident reporting and record keeping were identified during the accident studies for this project. The analyses of accidents required that copies of all accident records for the 1984-1987 period be obtained from Parkway Headquarters in Asheville. The NPS furnished copies of all accident reports and provided a computer listing of the 4-year accident history. Close examination of the records and the computer listing revealed both duplications and omissions. The lack of a consistent numbering system for each accident case report makes it extremely difficult to identify inconsistencies in the accident files.

Some information contained in the accident records was deficient or misleading. This problem became apparent while accident location diagrams were being prepared for the study. The milepost referenced in the reports did not always correspond closely with the actual location of the accident. Accidents in developed areas or parking lots were often referenced to the nearest milepost which did not provide a clear indication of the accident's true location. This deficiency should be eliminated through the use of a new accident reporting reference system recently implemented by the Parkway.

A typical Parkway accident case record contains the accident data form, statements from the parties involved in the incident, and a sketch of the accident scene. The data form was completed in all records examined for the study; however, statements and site sketches were not always included with the data form. These elements of the accident record are essential to the future analysis of data and understanding operational problems on the Parkway. Statements and sketches should be included whenever possible.

A comparison of the accident rate for the Blue Ridge Parkway (2.50 ACC/MVMT) to the average rate for ten units of the National Park System (3.33 ACC/MVMT) suggests the accident rate on the Parkway may be somewhat low. Although difficult to verify, it is possible that many property-damage-only accidents on the Parkway are unreported. This is most likely due to the length of the Parkway and the level of patrolling by NPS rangers.

2. Animal/Vehicle Accidents

Animal/vehicle collisions accounted for 15% of all Parkway accidents between 1984 and 1987. Ninety-three percent of these collisions involved deer. These incidents are attributable to the nocturnal habits of wildlife and reduced sight distance at night rather than deficiencies in the design of the Parkway. Although these accidents occur at random over the length of the Parkway, two areas with concentrations of animal/vehicle accidents (MP 80-100 and MP 130-148) were identified. The accidents in both locations are due to normal animal movements across the Parkway.

There is little that can be done to eliminate animal/vehicle accidents without affecting the characteristics of the Parkway. The use of deer-crossing warning signs (W11-3) is only recommended in areas where a heavy concentrations of animal crossings can be documented. The maintenance of an unobstructed area adjacent to the road in areas with animal migrations would not only improve sight distance but may reduce the frequency of animal/vehicle collisions.

3. Fixed-Object Accidents

Fixed-object collisions accounted for 46% of all Parkway accidents during the study period. Since most fixed-object collisions on the Parkway are run-off-the-road incidents, it is desirable to provide an unobstructed recovery area, as wide as possible, adjacent to the road. It is unfortunate but little can be done to make the mountainous topography adjacent to the Parkway less hazardous to vehicles that leave the road.

The fixed-objects most often involved in run-off-the-road accidents on the Parkway are natural objects, such as trees, rocks, and earth embankments or manmade objects such as traffic signs, curbs, bridges, and drainage structures. It is often not practical to remove or alter a natural object such as a large rock formation or steep embankment. However, the vegetation adjacent to the road can be controlled to produce a safer recovery area for errant vehicles. Careful design and placement of manmade objects along the roadside may also reduce fixed-object accidents over time. Photographs 1, 2, and 4 on Plate A show examples of fixed-objects adjacent to the Parkway.

A flat, clear, unobstructed roadside environment is desirable; however, it is not possible to provide such areas in many locations on the Parkway. This clear zone, the area that borders the road, starts at the edge of the travel way and is the only available space for safe use by errant vehicles.[1] The distances required for clear zones are based on vehicle speeds and the slopes of roadside areas. Guidance by the American Association of State Highway and Transportation Officials (AASHTO) indicates that clear zones which vary from 17 to 45 feet, depending on the slope of the shoulder, would be appropriate for the Parkway.[2] Studies have indicated that a 30-foot-wide clear zone permits about 80% of errant vehicles to recover safely on high-speed facilities.[3]

Photo Plate A

Photograph 1: An intepretive device located on the median island encourages visitors to stop and walk onto the median to read it, creating a potential pedestrian/vehicle conflict. The median island should be removed and this section of the Parkway redesigned to include a 2-lane roadway and a roadside parking area containing the intepretive device.

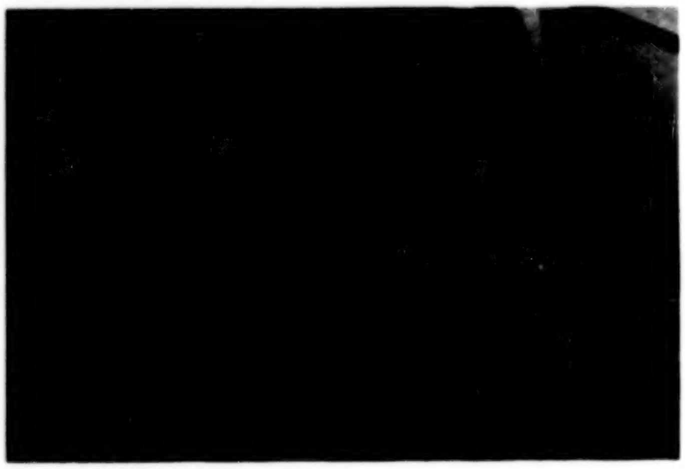
Photograph 2: The traffic at the entrance to the Folk Art Center at MP 382.0 has been channelized with a curbed median. The use of curbs and raised medians is not recommended on unlighted, high-speed roads because they act as a fixed-object in the roadway and cause an increase in accident severity.

Photograph 3: Concrete paving blocks have been used effectively in areas along the Parkway with excessive shoulder wear.

Photograph 4: The large rocks used to deter vehicles from stopping or parking on the shoulder of the Parkway should be replaced with enforced "No Parking" signs.

Photograph 1

Photograph 2



Photograph 3

Photograph 4

The following alternatives should be considered for treatment of roadside obstacles:[4]

- Remove the hazard.
- Relocate the hazard to a point where it is less likely to be struck.
- If it is not feasible to remove or relocate hazard, then consider treatment with a barrier.
- Leave the object unshielded only after reviewing the previous options.

The removal or relocation of a fixed object is obviously the most effective method of treatment.

It is recommended that all fixed objects that exist within 30 feet of the Parkway be removed or relocated where practical. Large trees should be removed if they are located within this 30-foot zone. Drainage structures and bridges present the greatest hazard of any man-made fixed-objects adjacent to the road. Efforts should be made to design and locate these features in a way that will lessen the chance that they will be struck by an errant vehicle.

4. Nighttime Accidents

Although only 18% of all Parkway travel occurs at dawn, dusk, or in the night, approximately 40% of all accidents on the Parkway happen during these low-light periods. This group of accidents accounted for 50% of all fatality accidents and 31% of all injury accidents during the four years of study. According to the accident records, alcohol was involved in 13.2% of the nighttime accidents. A nighttime evaluation of signing and striping on the Parkway was performed as part of this project. The results of the evaluation indicated that the signing and striping was clearly visible and had sufficient reflectivity. However, the roadway alignment in curves, at intersections, and on exit ramps was often difficult to identify at night due to a lack of adequate signing or striping.

The use of white edgelines along the Parkway would provide additional guidance for nighttime drivers. Information developed by AASHTO indicates that edgelines are desirable because they enhance the visibility of the road at night and should be used on all highways where adequate width (20 feet) exists.[5]

5. Motorcycle Accidents

The Blue Ridge Parkway has been identified by national motorcycle magazines as an excellent destination for motorcyclists. Classification counts conducted for this project determined that motorcycles accounted for about 1% of all traffic on the Parkway during the study period. However, the accident analyses for the Parkway have shown that motorcycles were involved in 15% of all accidents in the four years examined for this project. The severity of the motorcycle accidents was also significant, accounting for 50% of all fatality accidents and 34% of all injury accidents. Evaluations of these accidents suggests that excessive speed or reckless driving, not a deficient road design, was the primary contributing factor in most motorcycle accidents.

The Parkway currently uses a single-page informational document entitled "Cycle Alert" to advise motorcyclists of the inherent conditions on the Parkway and advises them to drive carefully. A brief narrative describing the accident statistics relating to motorcyclists (accident numbers, rates, and severity) may encourage more cautious driving on the Parkway. The Parkway staff should continue the distribution of this advisory document.

6. Accidents Related to Wet, Icy, or Snow-Covered Pavement

Approximately one-third of all Parkway accidents in the study period occurred on wet, icy, or snow-covered pavements. These conditions cause a reduction in skid resistance and in the effectiveness of pavement markings. The skid resistance of the Parkway's road surface was last tested in October of 1984 by the FHWA. These tests indicated that the skid resistance qualities of the pavement surface were good.[5]

Some portions of the Blue Ridge Parkway are closed when the pavement becomes covered with ice or snow. However, most of the Parkway remains open for travel throughout the year. The winter maintenance operations on the Parkway include plowing and sanding of all segments open to the public. Hinged signs are used at some locations to alert visitors of ice on the pavement. NPS should consider the use of a chip and seal application or a course-graded asphalt in those areas that have an extensive accident problem related to snowy or icy-road conditions.

A reduction in the ice- and snow-related accidents can be realized by increasing the frequency of surveillance and plowing or sanding operations. Increased monitoring of the road conditions on the Parkway is important because it is the only way that maintenance personnel know when and where plowing and sanding is needed.

Some State Highway Departments employ pavement sensors to forecast and detect the presence of ice or snow on the road surface. These systems consist of a pavement sensor, a small-weather data recording unit, and a computer that processes the weather data. The sensor, which is placed in the roadway, measures the temperature of the pavement and can detect the presence of moisture on the roadway surface. One system on the market uses telemetry to link as many as 32 sensors to the main data computer. Such a system could be used to alert maintenance personnel of the need for plowing or sanding at various locations along the Parkway. The system could also be used to automatically activate hinged warning signs at particularly hazardous locations. The cost of a pavement sensor system capable of monitoring one location is estimated at $150,000, with each additional monitoring location costing approximately $50,000.

C. Problems Identified through Field Observations

1. Parkway Intersections

The techniques used to control traffic at Parkway intersections and interchanges should be consistent from location to location. The application of sound design practices, combined with the provision of adequate sight distance and consistent use of traffic control devices is required to produce safe intersections. The recommended signing and striping for Parkway intersections and interchanges are shown in Figures 10 and 11.

2. Curbs and Medians

Curbs are used along the Parkway to facilitate surface drainage and to provide channelization for traffic flows. Curbing installed for drainage purposes is generally rounded, constructed of asphalt and are about 4 inches high. These curbs are typically located parallel and immediately adjacent to travel lanes. The size and shape of curbs used for drainage presents the least potential hazard of any of the curbing used on the Parkway. These curbs are essential to the drainage system and should be retained.

Curbs used to channelize traffic on the Parkway are typically constructed of granite blocks. Such curbs are 6 to 8 inches high, have vertical faces, and are angular in shape. The size, shape, and location of these curbs presents a fixed-object hazard to visitors. Plate A shows examples of the curbs typically used at median locations. These curbs are unnecessary and should be removed from the Parkway. This recommendation is supported by the NPS Park Road Standards which states, "Except where necessary to control traffic or drainage or to provide for road widening, the use of barrier curbs on roadways should be avoided for safety, economy, and simplicity".[6]

Extensive research on the safety effects of barrier curbs suggests that curbs constitute a roadside obstacle and are highly subject to impact. It has been found that curbs provide no safety benefits on high-speed highways from the standpoint of vehicle behavior following impact.[7] The researchers concluded that eliminating curbs along high-speed highways will enhance safety.[8] The AASHTO Design Policy indicates that, ". . . on rural high ways, caution should be exercised in the use of curbs. In the interest of safety, curbs should be omitted on rural highways when the same objective can be attained by other acceptable means".[9]

3. Roadway Shoulders

The shoulders along the Parkway are generally in good condition. There are isolated locations where ruts on the turf shoulder constitute a safety hazard. The initial rut in the shoulder, caused by an errant vehicle, will deepen over time as it carries storm run-off from the pavement.

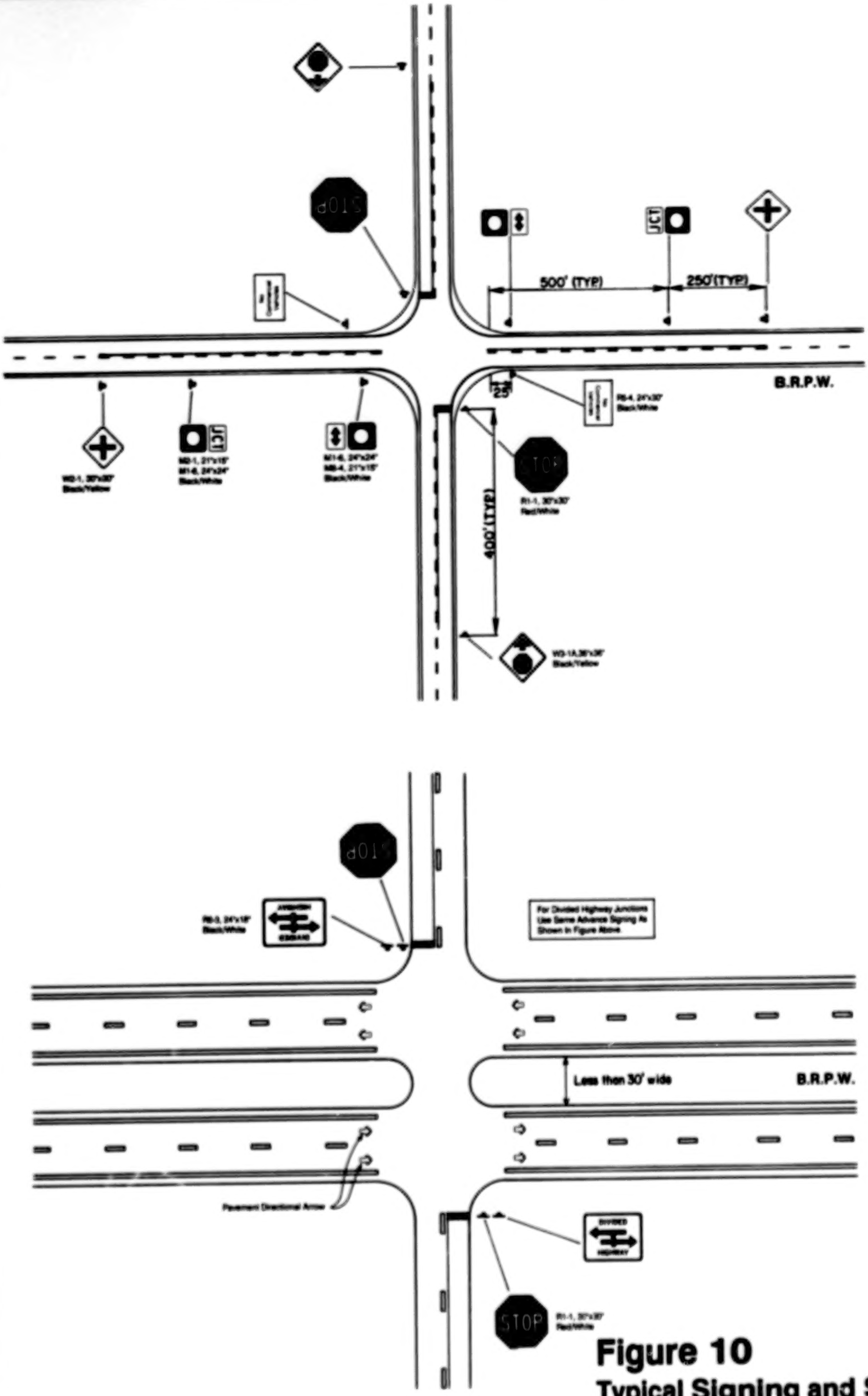


Figure 10
Typical Signing and Striping for At-Grade Intersections

Blue Ridge Parkway

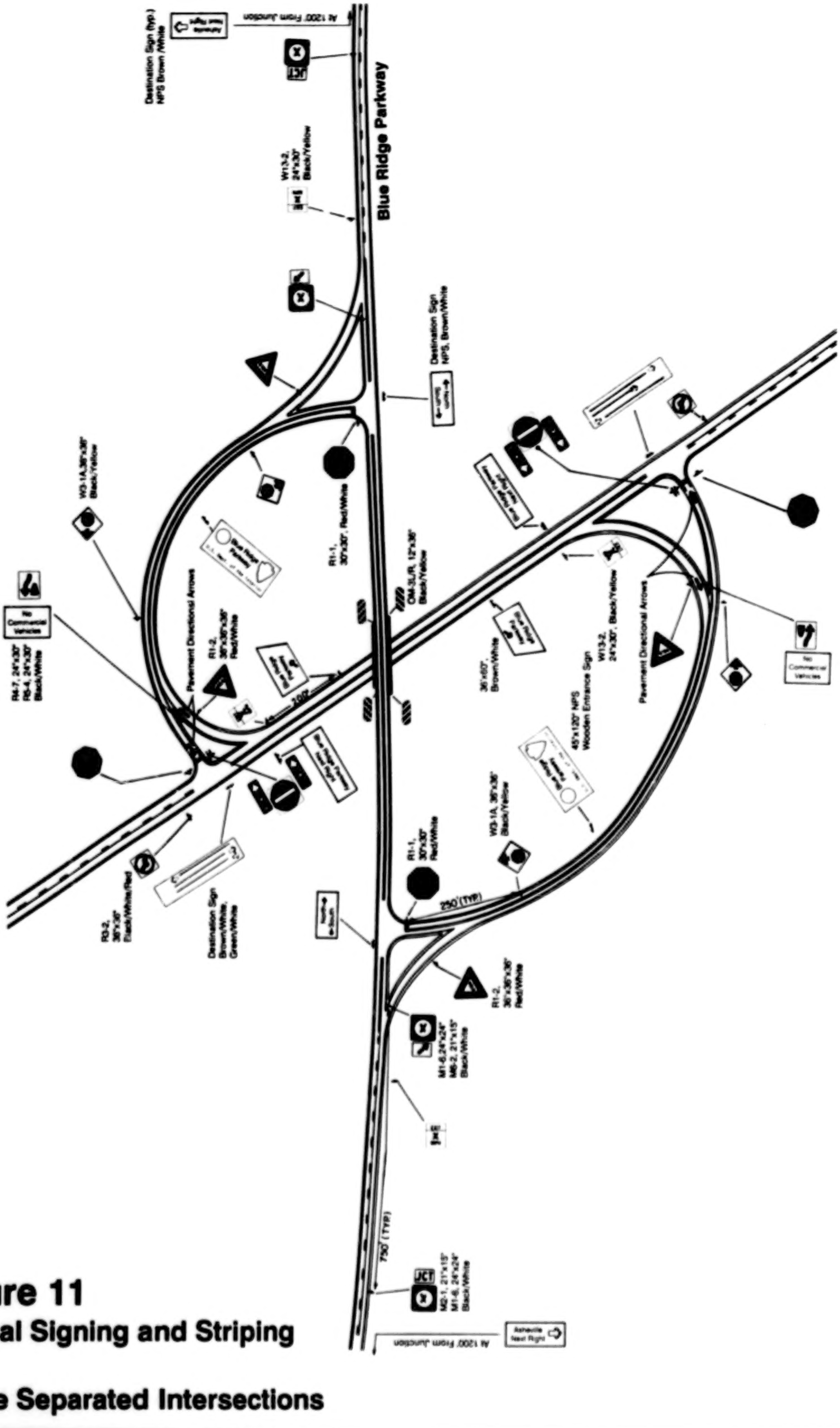

Blue Ridge Parkway
Destination Sign (typ.) NPS Brown/White
Asheville Next Right
At 1200' From Junction
JCT
W13-2, 24"x30" Black/Yellow
Destination Sign NPS, Brown/White
W3-1A, 36"x36" Black/Yellow
R1-1, 30"x30", Red/White
OM-3L/R, 12"x36" Black/Yellow
Pavement Directional Arrows
R1-2, 36"x36"x36" Red/White
R4-7, 24"x30" R5-4, 24"x30" Black/White
No Commercial Vehicles
100'
36"x60" Brown/White
W13-2, 24"x30", Black/Yellow
Pavement Directional Arrows
No Commercial Vehicles
45"x120" NPS Wooden Entrance Sign
W3-1A, 36"x36" Black/Yellow
R1-1, 30"x30" Red/White
250' (TYP)
R3-2, 30"x30" Black/White/Red
Destination Sign Brown/White, Green/White
North South
R1-2, 36"x36"x36" Red/White
M1-6, 24"x24" M6-2, 21"x15" Black/White
750' (TYP)
JCT
M2-1, 21"x15" M1-6, 24"x24" Black/White
Asheville Next Right
At 1200' From Junction

Figure 11
Typical Signing and Striping for Grade Separated Intersections

It is recommended that shoulder maintenance operations be upgraded to minimize this hazardous condition. A mixture of course gravel and topsoil should be placed, graded, and compacted in the problem areas. The NPS is encouraged to use concrete paving blocks in areas where wheel rutting on the shoulder has been a long-term problem. These blocks are currently in use in several areas on the Parkway and seem to provide a safe, effective, and aesthetic solution to the problem. Plate A shows an example of the paving blocks used in some shoulder areas of the Parkway.

4. Parkway Signing

There are three types of signs used on the Parkway including regulatory, warning, and guidance signs. These signs are generally correct with respect to sign color, shape, and mounting height. However, some signs used on the Parkway are undersized. The "Manual on Uniform Traffic Control Devices" (MUTCD) references the FHWA "Standard Highway Signs Booklet" as the source for determining the appropriate size of highway signs. This booklet identifies both a minimum size and a larger standard size for all regulatory and warning signs. Both sizes of regulatory and warning signs are currently used on the Parkway. The NPS Sign Manual[10] indicates the following:

> "All National Park Service roads - except four or more lane roads or parkways, are considered to be within the conventional road or street category referred to in the MUTCD. Standard size regulatory and warning signs as designated in the Standard Highway Signs Book should normally be used on these park roads. Parkways and four or more lane roads shall use standard sizes specified in this manual or larger, to conform with adjacent jurisdictional signs."

The FHWA "Standard Highway Signs Booklet" indicates that the standard size is 30"x30" for stop signs, 36"x36"x36" for yield signs, 24"x30" for speed limit signs, and 30"x30" for most warning signs. The Blue Ridge Parkway should establish a program for replacing the minimum size signs located on the Parkway with standard size signs.

The placement of the signs on the Parkway is correct in most cases. Several incorrect placements were noted where stop or yield signs are located on the left side of the road. These signs must always be placed on the right side of the road. An additional stop or yield sign may be installed on the left side of the approach road at intersections where a wide "throat" exists on the signed approach. The use of speed limit signs on the Parkway is in conformance with MUTCD.

The use of warning signs varies throughout the Parkway. Warning signs are used on the Parkway to alert motorists about roadway curves, intersections, tunnels, deer crossings, pedestrian crossings, and potential icing problems. The warning signs used on the Parkway were found to be correct in color (yellow and black) and shape.

The most notable deficiency on the Parkway relating to signing is the inconsistent use of curve warning signs. It is considered good signing practice to place the appropriate warning sign on any curve having a maximum safe speed that is 10 mph less than the posted speed limit. It is also desirable to install an advisory speed plate indicating the maximum safe speed beneath the sign for the curve when this condition is met. Appendix A includes speed limit. It is also desirable to install an advisory speed plate indicating the maximum safe speed beneath the sign for the curve when this condition is met. Appendix A includes a listing of 212 Parkway locations where curve warning signs are recommended. This listing was cross-checked with the milepost locations of all motor vehicle accidents that occurred during the study period to determine if any of these curve locations had significant accident histories. This analysis showed that a total of 135 accidents occurred at 84 of the curve locations during the 4-year study period. Four of these accidents produced fatalities and 59 produced injuries.

Parkway guidance signs are typically brown and white in color and present concise messages. Standard green and white guidance signs are also used in conjunction with the signing at intersections with major State or local roads. Guidance signs were found to be of adequate size and were properly placed along the Parkway.

All Parkway signing is mounted on standard breakaway posts. All signs were in generally good condition, although several instances were noted in which sign faces were delaminating and in need of replacement. An inventory system for traffic signs should be implemented to maintain data about each sign on the Parkway. This information should include the sign material, size, post type, date of installation, and date of last inspection or repair. A practice in which the date the sign was installed is marked on the back of each sign would be valuable during an inventory of the signing system.

The backs of all traffic signs should be painted brown to reduce the visual impact of signs on the Parkway environment.

5. Roadside Overlooks and Parking Areas

The design of the more than 255 roadside overlooks or parking areas on the Blue Ridge Parkway varies from location to location. Some roadside areas have been designed with specific traffic circulation patterns in mind. Directional arrows should be painted on the pavement to help identify the desired traffic movements in the larger parking areas. These arrows would be especially beneficial in one-way traffic situations. Curbed median islands are also used to channelize traffic in some roadside parking areas. The use of such curbs immediately adjacent to the Parkway is not recommended.

A deficiency common to many of these roadside parking areas is limited sight distance. Terrain or vegetation obstructs sight distance on the Parkway in the vicinity of the roadside areas. These obstructions make it difficult for visitors to safely enter or exit many of the roadside parking areas. This potential hazard should be addressed by providing adequate sight distance wherever practical. Consideration should be given to relocating overlooks or other wayside areas in locations where available sight distances are extremely limited and can not be improved.

Appendix B contains a list of 87 roadside parking areas that were found to have some type of safety deficiency. Three primary deficiencies are identified in the list including the absence of advance signing, the presence of curbed medians, and sight distance limitations.

A field review should be conducted by NPS at each roadside area listed in Appendix B. NPS should verify the deficiencies identified at each site to determine if corrective measures should be implemented.

6. Developed Areas

The major developed areas on the Parkway were examined as part of this study. The most common deficiencies identified at these areas was the lack of separate parking areas for RVs and a general need for more passenger vehicle parking. There is also a need for additional guidance to indicate the desired traffic circulation, particularly in areas where one-way traffic conditions exist. Directional arrows painted on the pavement are recommended in such situations.

Traffic safety deficiencies and specific comments concerning various developed areas on the Parkway are listed below:

MP 5.7	Humpback Rocks	There is no designated RV parking area. The 24-inch stop signs should be replaced with standard 30-inch by 30-inch signs. Painted stop bars should be installed adjacent to the stop signs.
MP 60.9	Otter Creek	There is no designated RV parking area.
MP 63.8	James River	There is no designated RV parking area.
MP 86.0	Peaks of Otter	The parking areas at this development are undersized. Overflow parking is required for 4 to 5 months out of the year. There is no separate RV parking area. The traffic circulation near the visitor center is poor due the multiple access points and the medians that divide the Parkway. The signing at this site is excessive and ineffective. (See detailed evaluation of this site in the following chapter.)
MP 120.4	Roanoke Mountain	The one-way exit should be more clearly marked with a no-left turn and a no-right turn sign on both Parkway approaches. The "T" intersection at the top of the mountain should be controlled by a stop sign located on both the right and left sides of the approach road. The stop signs should be 30 inches by 30 inches in size.
MP 154.5	Smart View	There is no designated RV parking area.
MP 169.0	Rocky Knob	There is no designated RV parking area.
MP 176.1	Mabry Mill	The signing leading to the overflow parking area should be improved. The access road to the overflow lot should be widened to at least 20 feet in width to accommodate RV traffic.
MP 217.5	Cumberland Knob	This development uses a one-way traffic flow pattern. This fact needs to be emphasized by installing painted directional arrows on the pavement and entrance and exit

signs that will make the required traffic movements clear to visitors approaching the site on the Parkway.

MP 238.5	Brinegar Cabin	The stop sign, placed on the median island at the Parkway junction, is incorrectly located. The stop sign must always be located on the right side of the approach road. A second stop sign can be installed on the left side of the approach to reinforce the sign on the right if additional emphasis is required.
MP 241.8	Doughton Park	The pedestrian trail system at this site crosses the Parkway at 4 locations. These crossings should have advance pedestrian warning signs and painted crosswalks. The sight distance in the areas where pedestrians cross should be improved. There is no designated RV parking area.
MP 258.6	Northwest Trading Post	The area would benefit from the installation of directional arrows painted on the pavement, even though the one-way traffic circulation in the parking area functions well. There is no designated RV parking area.
MP 272.0	E.B. Jeffress Park	There is no designated RV parking area.
MP 294.1	Moses H. Cone Craft Center	The one-way traffic pattern could be improved through the use of directional arrows painted on the pavement near the entrance and exit to the parking lot. There is no designated RV parking area.
MP 331.0	Mineral Museum	There is no RV parking area.
MP 339.1	Crabtree Meadows	The traffic control signs at this area are undersized. The one-way traffic pattern would benefit from the installation of arrows painted on the pavement. There is no designated RV parking area.
MP 364.1	Craggy Dome Overlook	Directional arrows painted on the pavement would help the one-way traffic circulation at this site. The left turn required to pass between the two parking lots appears to be difficult for long RV units to negotiate. There is no designated RV parking area.
MP 364.7	Craggy Gardens Visitor Center	The layout of this site encourages uncontrolled access and egress from the parking lot. There is also potential for numerous vehicle-pedestrian conflicts which is compounded by sight distance limitations. It is recommended that the visitor center be eliminated and converted into a standard overlook parking area with defined and controlled accesses at some future date. The visitor center could be relocated to the Craggy Dome area where level ground is available for the building and an expanded parking area.

MP 367.5	**Craggy Gardens Picnic Ground**	**The stop sign, located on the median island and to the left side for approaching traffic, should be placed on the right side of the approach road.**
MP 382.0	**Folk Art Center**	**It is recommended that the curbed median islands at the Parkway junction be removed.**
MP 408.6	**Mt. Pisgah**	**There is no designated RV parking area.**

7. Pavement Markings

Pavement markings on the Parkway consist of yellow centerline striping, white edgeline striping (in tunnels only), white stop bars, and white directional arrows. Painted stop bars and directional arrows are rarely used to control traffic on the Parkway. Painted stop bars should be used in conjunction with all stop signs because they provide an effective means of reinforcing the stop condition and identify the preferred location for stopping. Directional arrows painted on the pavement are recommended where one-way traffic exists or where intersection geometrics may be confusing or unusual.

The use of white edgeline striping is a standard practice on most major rural and urban roads in the U.S. The results of tests by the FHWA indicate that delineation of the outside edges of the traveled lanes is highly desirable on 2-lane rural roads which have paved surfaces of at least 20 feet in width. It has been conclusively demonstrated that edgeline delineation results in significantly less lateral deviation by the operators of vehicles, reduces driver stress, and reduces the accident potential of the roadway.[11] There is substantial evidence that edgeline markings provide necessary guidance to the motorist, especially as visibility decreases due to weather and/or nighttime conditions.[12]

It is recommended that 4-inch-wide, white shoulder stripes be installed over the length of the Parkway. It is believed this edgeline striping will be beneficial during periods of fog, wet-road conditions, and at night. Edgeline striping is especially needed on the interchange ramps where the roadway alignment changes rapidly.

Centerline striping is an integral part of the traffic control system and provides essential information regarding safe passing maneuvers on this 2-lane highway. Warrants used to establish no-passing zones are contained in the MUTCD and are based on vehicle speeds and minimum passing sight distances. The FHWA revised the warrants for no-passing zones to address the current trend towards lower profile vehicles in March of 1984. The revisions primarily focused on the methods used to measure passing sight distance. The standard heights for the eye of the observer and the object were lowered from 3.75 feet to 3.50 feet and from 4.25 feet to 3.50 feet, respectively. The FHWA identified March 1, 1989, as the date when all public roads were to be in accordance with the revised warrants.

The centerline striping of the Blue Ridge Parkway was evaluated to determine the appropriate locations for passing and no-passing zones as a part of this project. A complete listing of all no-passing zones is presented in Appendix C of this report. The existing centerline striping on the Parkway was found to be in good condition and easily visible during both daylight and nighttime driving conditions.

8. Tunnels

There are 26 tunnels on the Parkway, however, only 4 tunnel-related accidents occurred during the study period. Based on this accident history, there appears to be no major traffic safety problems associated with the tunnels. It is believed this low-accident frequency is partially due to the consistent use of signing, striping, and delineation. An inventory of each tunnel was conducted to determine its physical characteristics and identify the traffic controls used at each site. This information is presented in Table 8.

The road design policy developed by AASHTO recommends minimum vertical clearances of 14.5 feet and minimum horizontal clearances of 30 feet for 2-lane tunnels.[13] All of the Parkway tunnels are 29.5 feet or wider, but 16 tunnels have minimum vertical clearances that are less than the AASHTO's recommended standard. The driving surface in all tunnels on the Parkway is at least 22 feet wide.

The advance signing for each tunnel consists of a "Tunnel" warning sign (24"x24"), a "Turn Lights On" sign (18"x24"), and a plate which identifies the name of the tunnel (24"x36"). These signs are correctly placed with the initial warning sign located 500 to 800 feet in advance of the tunnel entrance. A "Check Lights" sign (18"x36") is typically provided within 300 feet of the tunnel's exit. The only deficiency identified with respect to tunnel signing was the use of undersized warning signs. All "Tunnel" warning signs should be 30"x30" instead of the smaller 24"x24" signs.

The pavement markings used in the tunnels includes yellow center lines and white edgelines. Reflectorized, raised pavement markers are used in addition to the centerline and edgeline striping in some tunnels. Since this treatment appears to be very effective, it is recommended that amber-colored, raised pavement markers be installed on the centerlines to supplement striping in all tunnels.

A variety of reflectors and painted markings are used on the walls of the Parkway's tunnels. Field observations suggest that the most effective type of wall identification is the 3"x24" bar reflector. The bar reflectors currently used in the tunnels have orange and white stripes. These reflectors are shown in Plate B. The orange-and-white striped reflectors are typically used in conjunction with construction or maintenance acticities. Solid white reflectors would be more appropriate for use in this case. It is recommended that solid white bar reflectors (3"x24") be installed along both walls of each tunnel on the Parkway.

Raised curbing is used at two tunnel locations on the Parkway, the Twin Tunnels at MP 344.6 and 344.7. The curbing is located between the outside edge of the driving lane and the tunnel wall. This curb should be removed because it presents a potential hazard as a fixed-object.

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Table 8
Summary of Tunnel Features

Milepost	Name	Maximum Length	Minimum Height	Total Height	Pavement Width	Advance Width	Centerline Signing	Shoulder Reflectors	Wall Reflectors	Edgeline Reflectors	Striping
53.1	Bluff Mountain	630'	19' 1"	13' 0"	30.0'	22.0'	X	X		X	X
333.4	Little Switzerland	547'	19' 8"	14' 3"	30.0'	23.0'	X	X	X	X	X
336.8	Wildacres	249'	19' 10"	15' 0"	30.4'	23.0'	X	*	*	*	*
344.6	Twin Tunnel #1	240'	21' 0"	15' 11"	33.0'	23.0'	X	*	*	*	*
344.7	Twin Tunnel #2	401'	19' 7"	15' 9"	32.0'	23.0'	X	*	*	*	*
349.0	Rough Ridge	245'	21' 6"	15' 11"	30.0'	23.0'	X	*	*	*	*
364.5	Craggy Pinnacle	176'	19' 9"	14' 3"	31.0'	22.5'	X			X	X
365.5	Craggy Flats	335'	19' 5"	13' 4"	29.75'	22.0'	X	X	X	X	X
374.4	Tanbark Ridge	746'	19' 5"	14' 8"	29.8'	22.5'	X	X	X	X	X
397.1	Grassy Knob	600'	19' 2"	14' 7"	29.5'	22.5'	X	X	X	X	X
399.3	Pine Mountain	1,320'	19' 3"	14' 7"	30.0'	24.0'	X			X	X
400.9	Ferring Knob #1	360'	19' 6"	14' 5"	30.0'	23.0'	X			X	X
401.3	Ferring Knob #2	310'	19' 2"	14' 0"	30.0'	23.0"	X			X	X
401.5	Ferring Knob #3	230'	19' 5"	14' 4"	30.0'	23.0'	X			X	X
403.0	Young Pisgah Ridge	400'	19' 8"	14' 3"	30.0'	27.0'	X			X	X
404.0	Fork Mountain	350'	19' 2"	14' 5"	29.0'	25.0'	X			X	X
406.9	Little Pisgah	500'	19' 5"	14' 11"	30.5'	27.0"	X			X	X
407.3	Buck Spring	462'	19' 2"	14' 4"	29.5'	25.0'	X				X
410.1	Frying Pan	275'	19' 9"	14' 10"	30.0'	25.5'	X			X	X
422.1	Devil's Courthouse	650'	19' 0"	13' 5"	29.5'	22.5'	X	X	X	X	X
439.7	Pinnacle Ridge	750'	19' 1"	13' 2"	30.0'	23.0'	X	X	X	X	X
458.8	Lickstone Ridge	402'	18' 1"	11' 10"	29.5'	23.0'	X	X	X	X	X
459.3	Bunches Bald	268'	18' 4"	11' 7"	29.5'	23.5'	X	X	X	X	X
461.2	Big Witch	348'	18' 1"	13' 1"	29.5'	23.5'	X	X	X	X	X
465.5	Rttlesnake Mountain	410'	19' 6"	13' 5"	31.0'	22.0'	X	X	X	X	X
466.3	Sherrill Cove	572'	19' 7"	15' 0"	29.5'	22.0'	X	X	X	X	X

* Tunnels under construction; no data available.

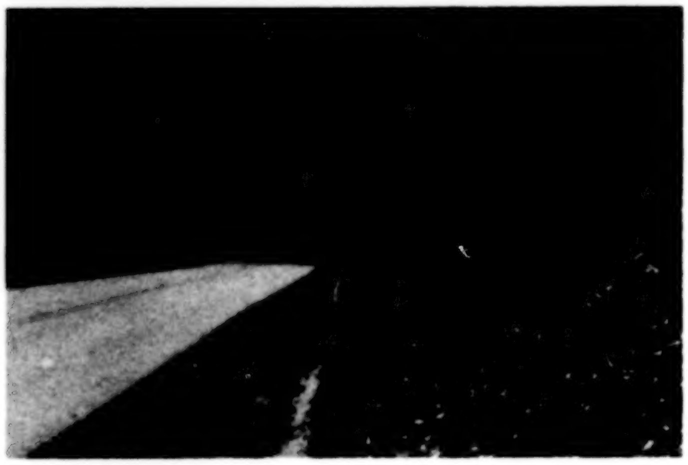
Photo Plate B

Photograph 1: This curve warning sign and 25 mph sign do not conform with MUTCD. A turn warning sign should be used for curves with maximum safe speeds of 30 mph or less. The 25 mph advisory speed should be presented on a rectangular-shaped sign. Note the delamination of the sign face on the lower sign.

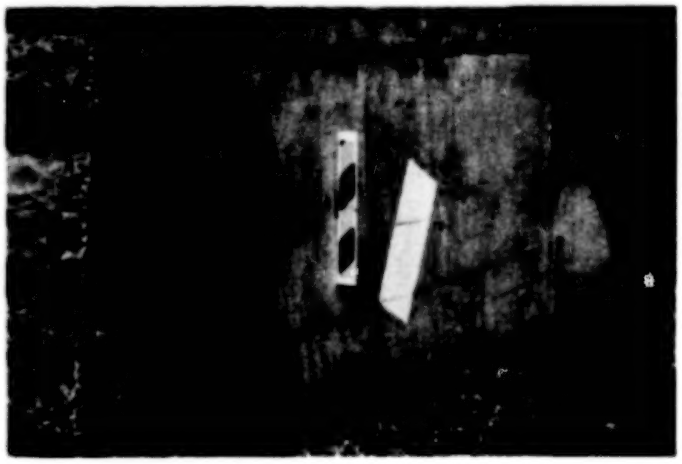
Photograph 2: Reflectorized paint and wall-mounted reflectors used in many tunnels. The use of solid, white reflectors (3"x24") is recommended for the walls of Parkway tunnels.

Photograph 3: Older, timber guiderails along the Parkway are being replaced with new steel-backed, timber guardrails.

Photograph 4: The barricade gates used to temporarily close the Parkway do not conform with the barricade requirements outlined in the MUTCD.



Photograph 1



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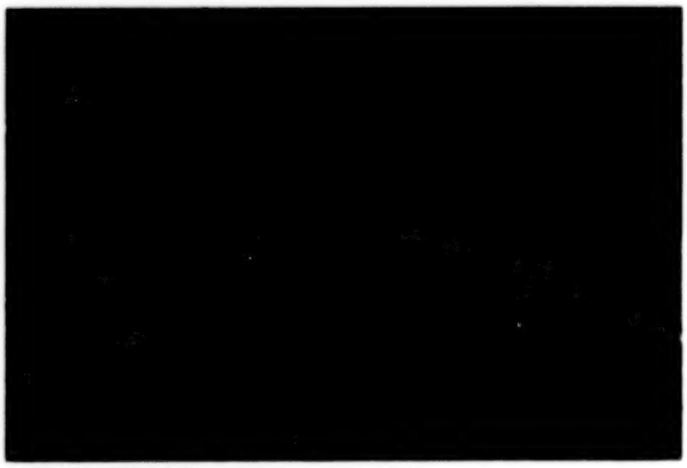


Photograph 3

Photograph 4

9. Guiderails and Guardrails

Timber guiderails mounted on wood or concrete posts are commonly used throughout the Parkway. Many of these older guiderails are mounted low which reduces their effectiveness. Standard mounting heights for these timber guiderails range from 27 to 33 inches above the adjacent pavement surface. These guiderails are gradually being replaced with a guardrail of similar design that is reinforced with steel panels attached to the backs of horizontal members. The new guardrails on the Parkway have been installed according to accepted standards for placement and mounting height. An example of the new guardrail is shown in Plate B.

10. Traffic Counting Program

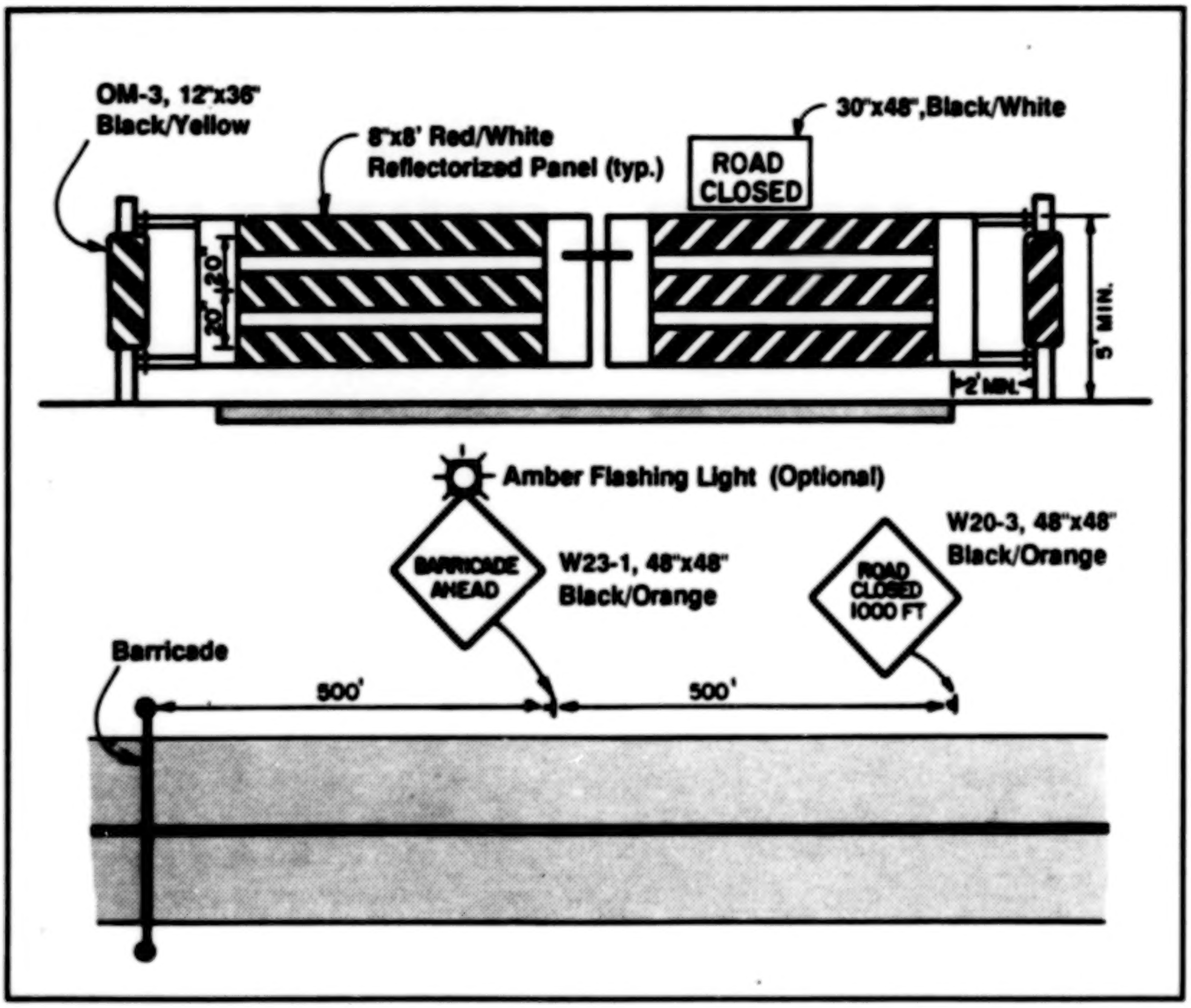
Accurate records of traffic volumes are necessary to evaluate the performance of a road system. Currently, only 2 permanent traffic counters on the Blue Ridge Parkway continuously record 2-way traffic volumes with supplemental blanket counts taken annually at selected count locations. These counters are located at the north and south ends of the Parkway (MP 0.0 and MP 469.0). The NPS operates 56 other traffic counters at various locations on the Parkway; however, these counters only provide volumes for vehicles entering the road system. There is a definite need to monitor 2-way traffic volumes on the Parkway. Therefore, it is recommended that permanent traffic counters be installed at other locations to provide useful data about vehicle activity on various sections of the Parkway.

11. Barricade Gates

Temporary barricades and gates are used to close sections of the Parkway for major maintenance work and to restrict driving during the winter. The design of the gates used on the Parkway does not meet MUTCD standards for barricades. The existing gates are made of steel piping and equipped with orange and white, reflectorized tape and a black and white "Road Closed" sign as shown in Plate B. The advance signing for the barricade gates usually consists of a single (24"x24") "Barricade Ahead" warning sign.

The MUTCD states that a Type III barricade shall be used at the points of closure whenever a road is legally closed to the public.[17] An example of the recommended barricade treatment and advance signing for such installations is shown in Figure 12. Note that the advance warning signs recommended for this use are 48"x48" in size.

Figure 12
Recommended Barricade Treatment



References

1. "Guide for Selecting, Locating, and Design of Traffic Barriers", AASHTO, 1977, p. 15.

2. "Guide for Selecting, Locating, and Design of Traffic Barriers",AASHTO, 1977, p. 16.

3. "Highway Design and Operational Practices Related to Highway Safety", AASHTO, 1974, p. 37.

4. "Highway Design and Operational Practices Related to Highway Safety", AASHTO, 1974, p. 38.

5. "Highway Design and Operational Practices Related to Highway Safety", AASHTO, 1974, p. 66.

6. Park Road Standards, U.S. Department of the Interior, NPS, Washington, DC, 1984, p. 33.

7. "Effects of Curb Geometry and Location on Vehicle Behavior", National Cooperative Highway Research Program Report 150, Transportation Research Board, National Research Council, Washington, DC, 1974, p. 15.

8. "Effects of Curb Geometry and Location on Vehicle Behavior", National Cooperative Highway Research Program Report 150, Transportation Research Board, 1974, p. 15.

9. "A Policy on Geometric Design of Highways and Streets", AASHTO, 1984, p. 372.

10. National Park Service Sign Manual, January, 1988, p. 4-1.

11. "An Overview of Roadway Delineation Research", FHWA, June 1978, p. 65.

12. "An Overview of Roadway Delineation Research", FHWA, 1978, p. 65.

13. "A Policy on Geometric Design of Highways and Streets, AASHTO, 1984, p. 425.

14. Park Road Standards, U.S. Department of the Interior, NPS, Washington, DC, 1984, p. 32.

15. "Guide for Selecting, Locating, and Designing Traffic Barriers", AASHTO, 1977, p. 16.

16. "Manual on Uniform Traffic Control Devices, FHWA, 1978, p. 66-67.

Chapter VI: Identification and Evaluation Process for Specific High-Accident Locations

A. Site Identification Process

The accident data obtained from the NPS for the period of January 1, 1984 through December 31, 1987 provided the basis for the high-accident site identification process. The first phase of the process included an analysis of the accident records to identify all 0.2-mile-long sections of the Parkway that had six or more accidents and an accident rate of at least one accident per million vehicles entering. This initial examination produced a total of 38 sites which met the criteria for consideration as high-accident locations.

Each candidate site was visited in an effort to determine the exact location and cause of the accidents. The purpose of the site visit was to identify specific locations which should be considered for further evaluation. The accidents that were reported in many of the 0.2-mile-long segments were totally unrelated and did not indicate any identifiable problems in the roadway design. Accidents at other candidate locations actually occurred in adjacent parking areas or campgrounds and not at the milepost referenced on the accident form. The on-site review enabled the researchers to identify only those locations where the accident rate and severity suggested deficiencies with the road design or the informational system.

A meeting was held with NPS personnel and Parkway staff to discuss the findings of the accident review and site visit. Based on comments received from the NPS, the initial 38 sites were reduced to 20 locations for further evaluation.

B. Sites Selected for Further Examination

The 20 high-accident locations on the Blue Ridge Parkway that were selected for further investigation are listed in Table 9 and identified on Figure 13.

C. Site Evaluation Process

A systematic approach employing historical accident research; physical measurements of site conditions; observations of driver characteristics and quality of travel; and subjective ratings of the driver's perception of the site was used in the evaluation of each high-accident location. The data collected through these procedures identified the circumstances or conditions that make these specific locations on the Parkway more hazardous than others. The following narrative describes each activity performed during the data collection phase of this project.

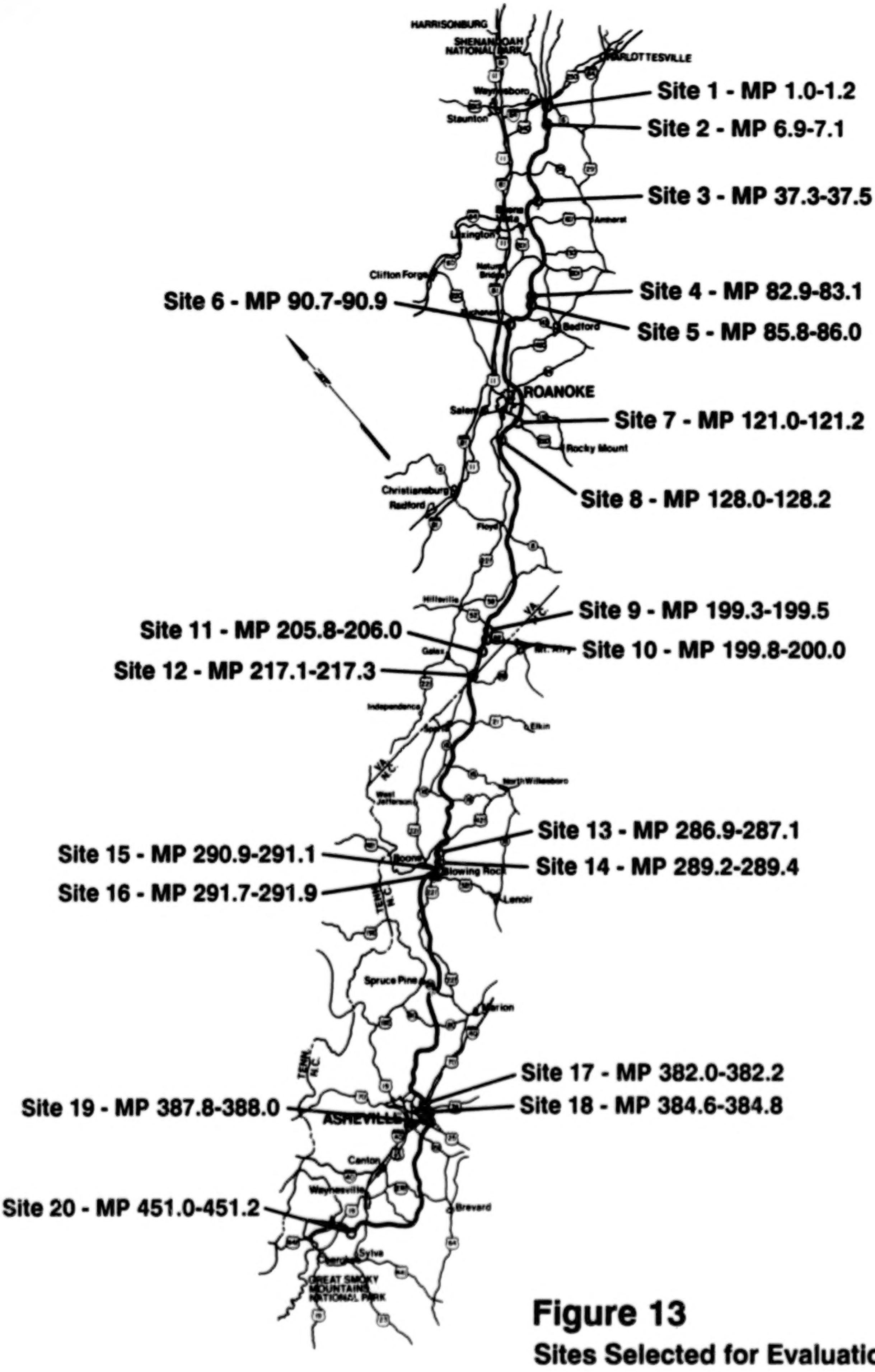


Figure 13
Sites Selected for Evaluation

Table 9
Sites Selected for Evaluation

Site No.	Milepost	Site Description	Number of Accidents (1984 - 1987)	Accident Rate (ACC/MVE)
1	1.0 - 1.2	Curves north of Rockfish Valley Overlook	10	13.61
2	6.9 - 7.1	Curve south of Humpback Gap	7	9.52
3	37.3 - 37.5	Irish Gap	9	21.02
4	82.9 - 82.1	Fallingwater Cascades	8	17.36
5	85.8 - 86.0	Junction State Route 43 at Peaks of Otter	23	28.22
6	90.7 - 90.9	Curve north of Bearwallow Gap	6	13.02
7	121.0 - 121.2	Junction U.S. 220	17	6.51
8	128.0 - 128.2	Curve north of Metz Run Overlook	6	8.80
9	199.3 - 199.5	Junction U.S. 52	10	4.05
10	199.8 - 200.0	Junction State Route 778	6	3.97
11	205.8 - 206.0	Curve north of Pipers Gap	10	7.20
12	217.1 - 217.3	Junction State Route 18	12	8.39
13	286.9 - 287.1	Curve north of Aho Gap	13	10.49
14	289.2 - 289.4	Curve north of Raven Rock Overlook	8	6.45
15	290.9 - 291.1	Thunder Hill	6	4.84
16	291.7 - 291.9	Junction U.S. 321/221	12	4.72
17	382.0 - 382.2	Junction U.S. 70	10	1.43
18	384.6 - 384.8	Junction U.S. 74	36	4.75
19	387.8 - 388.0	Curve north of U.S. 25	18	3.28
20	451.0 - 451.2	Waterrock Knob	6	5.72

1. Preparation of Collision Diagram

All accidents recorded during the study period were thoroughly examined and plotted on a sketch of each site. The collision diagrams graphically summarize each accident and its pertinent characteristics. These diagrams facilitated the reconstruction of individual accidents in the field.

2. Initial Site Visit

The consultant visited each location to observe the site and to accurately locate all accidents that occurred within it during the period of study. A review of the site's accident history is often beneficial in the determination of its problems and deficiencies. A subjective rating of driver expectancy (the driver's perception of the site) and the presentation of traffic control devices was also performed to assess the drivability of each site.

3. Site Survey

Field technicians utilized survey equipment to measure the physical layout of the site. Data gathered during the survey included average road grades, road widths, road alignment, and superelevation in curves. This information supplemented existing data obtained from Parkway construction plans. Stopping-sight distance and, where applicable, passing-sight distances were determined in the field for all high-accident locations. Ball-bank testing (using a safe-curve-speed indicator) was performed, as needed, to verify posted advisory speeds for sites with curves.

4. Site Photography

Photographs were taken to illustrate specific characteristics or to identify site deficiencies. These photographs were used extensively during the preparation of the report. The "on-the-ground" photographs were supplemented with aerial photographs of each site.

5. Identification of Site Features

This phase of the data collection involved extensive field measurements of site features including sign locations, pavement markings, location of medians, and other roadside objects. Coordination between field measurements and site photography resulted in the production of accurate graphics for each location. Measurements of sign sizes were also conducted to assess their conformance to MUTCD and NPS standards.

6. Traffic and Turning-Movement Counts

All available traffic count data was obtained from the NPS and State Highway Departments. A four-hour count of vehicle-turning maneuvers was conducted to supplement traffic count data if a high-accident location included a major intersection. The traffic count data was used to determine average daily traffic and to calculate accident rates.

7. Traffic-Conflicts Studies

A traffic-conflicts study was conducted for all high-accident sites that included intersections. A scientific sample of drivers was selected and observed for major approaches within the sites. Tallies of driving violations and conflicts were recorded for each approach. Data obtained from these studies produced actual measurements of how motorists perceived and responded to physical conditions at each site. This information was very meaningful when compared to the consultant's subjective ratings of drivability at each high-accident location.

8. Vehicle Speed Studies

Vehicle speeds were determined through spot speed testing with radar equipment. This data was needed to determine average travel speeds, to evalute the effectiveness of traffic controls, and to generally assess the physical characteristics of the site.

9. Site Deficiencies and Recommendations

The results of all site-specific traffic tests and the accident analyses were used to identify traffic-safety problems, engineering deficiencies, and hazardous conditions. Corresponding recommendations were formulated to address existing problems at each high-accident location.

D. Development of the Hazard Index and the Priority Indices

The ultimate objective of the site evaluations was to identify improvement projects that will reduce accidents or alleviate problems at each of the sites. Since each site satisfied the criteria for consideration as a high-accident location, it is apparent that all sites demand some type of action. A procedure based on methods outlined in an FHWA report, entitled Identification of Hazardous Locations (Report No. FHWA-RD-77-83), was used to develop an order for implementing improvements at the high-accident locations. This procedure considered the relative hazardousness of the site and the cost of recommended improvements at each location to determine the order for implementing projects.

This ranking, known as the priority index, was based on the development of a hazard index and a cost factor for each site. The hazard index calculation considered 3 accident indicators (number of accidents, accident rate, and accident severity) and 3 non-accident indicators (sight distance ratio, driver expectancy, and inforamtion system deficiencies). A value, ranging from 0 to 100 with 0 representing no hazard and 100 representing the most hazardous condition, was assigned to each indicator. The indicator values were then weighted and totaled to yield the hazard index. The cost factor represents the improvement cost per vehicle and is computed by dividing the total cost for the recommended improvements by the number of vehicles entering the location during the service life of the improvements.

The priority index, a weighted average of the hazard index and the cost factor, evaluates the relative hazardousness of each site and the cost of the recommended improvements. This index was used to rank each site and should be the primary guide for implementing improvements at the 20 high-accident locations. A benefit/cost ratio for the recommended improvements at the sites was also calcuated for use by the NPS.

It should be noted that the priority index and the benefit/cost ratio calculations are based only on the short-term improvements recommended for each site. Long-term improvements were not prioritized due to the uncertain costs and time frames involved in each recommendation.

An explanation of each hazard indicator and the forms or tables used to determine the hazard index, cost factor, priority index, and benefit/cost ratio are presented in Appendix D.

Chapter VII: Analysis of Individual High-Accident Locations

A. General

The following narrative contains a discussion of the physical layouts, the operational characteristics, and the accident histories for twenty high-accident locations on the Blue Ridge Parkway. This information, combined with the results of various on-site traffic studies, was used to identify the cause(s) of the high rate of accidents at each site. Recommendations were formulated for improvements which will reduce the frequency and/or severity of accidents at each site. Most of the recommended improvements involve limited construction and are designed to provide direct benefits to the motorists using the existing road system. The improvements are generally low-cost items and should be easily implemented by NPS personnel. Coordination with state and county highway departments will be required because some recommendations fall outside NPS jurisdiction. Full implementation of the recommendations contained in this document will depend upon the response and cooperation of these outside agencies.

B. Individual Site Evaluations

The evaluation of each high-accident location on the Blue Ridge Parkway contained in the following pages consists of: 1) a discussion of existing physical features including road grades, signing, and striping; 2) a summary of the site's accident history with a table summarizing important accident characteristics and a detailed collision diagram; 3) aerial and "on-the-ground" photography of the site to clearly identify physical features or problems; 4) a list of recommended improvements and approximate costs; 5) a figure identifying all recommended improvements; and 6) the calculations of the hazard index. A benefit/cost ratio for the improvements at each site has also been provided.

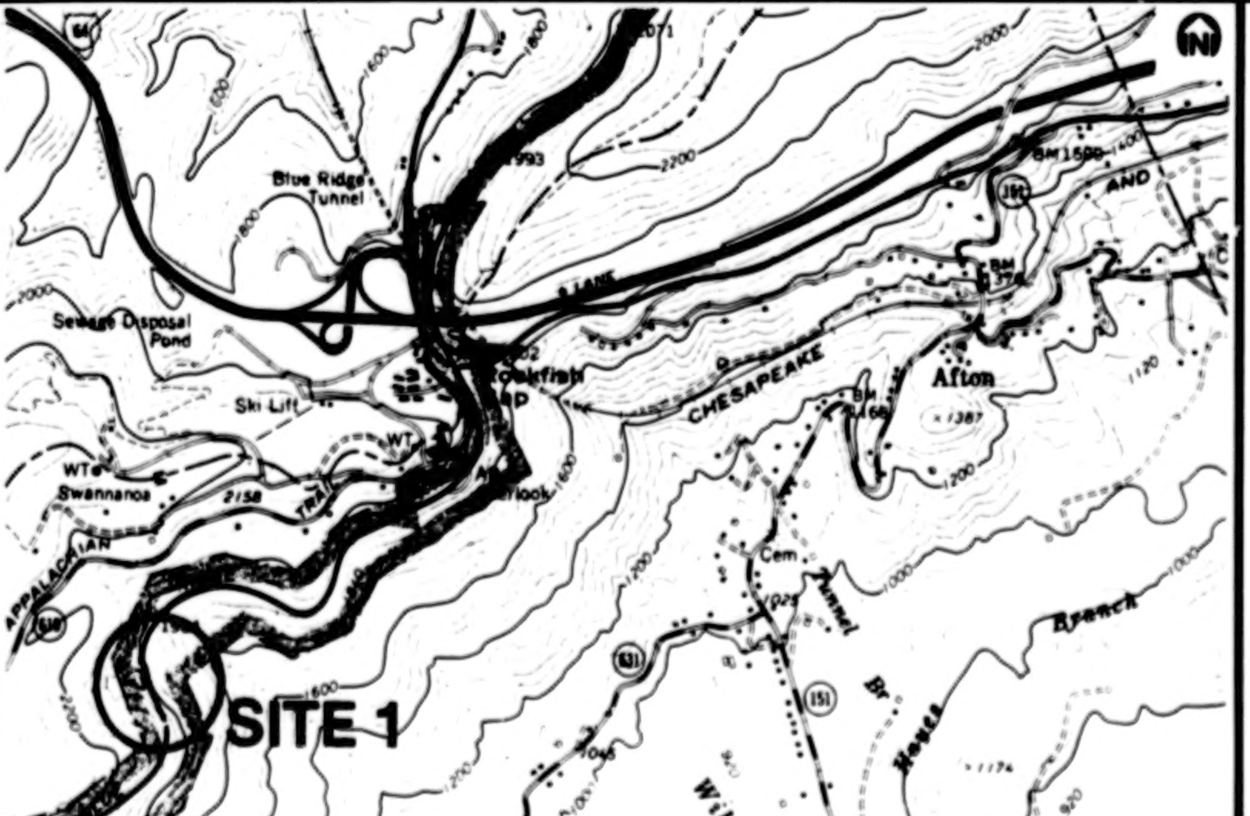
C. Recommended Site Improvements

The existing signing for each site (shown in black on the figures contained in this chapter) is correct in its size, shape, and placement unless otherwise specified. Recommendations at each site are depicted in red. The recommendations for new signs include MUTCD sign reference numbers, sign sizes, and placement suggestions. The cost estimates provided for each improvement are approximate and intended for planning purposes only. The improvement costs were estimated, where possible, from recent NPS bid tabulations for projects on the Blue Ridge Parkway.

SITE 1

Existing Conditions

This site consists of a road segment located between Mileposts 1.0 and 1.2 near the northern terminus of the Blue Ridge Parkway. The site, located southeast of Rockfish Gap near Waynesboro, Virginia, is shown on the map at the bottom of this page. Site 1 consists of a sweeping, reverse horizontal curve with grades ranging from 1.5% to a maximum of 12%. Superelevations in the curves were measured at 11%. The entire site has been striped with a double solid yellow centerline which prohibits passing. An asphalt-lined drainage channel has been installed along the west side of the roadway. The road surface and centerline striping throughout the site is in good condition. The width of the road varies from 21.0 feet to 22.5 feet in the curves. Existing signing includes a curve warning sign (W1-2) at the north end of the site and an "Overlook Ahead" sign near the south end of the site. Average daily traffic on this section of the Parkway is estimated to be approximately 600 vehicles.



Site Location

Blue Ridge Parkway MP 1.0 to 1.2

Accident History

Ten single-vehicle accidents occurred during the study period. Four of the accidents produced injuries. Fixed objects were struck in seven cases. One such collision caused a vehicle roll-over after the car struck the cut slope. Eight of the accidents happened on dry pavement, and six occurred at night. The most common accident consisted of a vehicle traveling north (downgrade) and leaving the right side of the roadway in the curve at MP 1.2. The accident history indicates that excessive vehicle speed and inability of the driver to properly identify the curve alignment was most likely the cause of six of the ten accidents. Figure 1A identifies the locations of the ten accidents at this site. A summary of accident characteristics during the study period is presented below.

ACCIDENT DATA

SITE 1: MP 1.0 - 1.2 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
1	1	3	5

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
	2	1	2	1	2	2

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	1	1			3			1	2	2	

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	1		1						1			1				2		1		1		2	

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
4	6		

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
8	1		1	

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
9	1		

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
		7		1		2			

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
4	2	1	3					

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)		1 (1)	2 (5)	1 (2)	4 (8)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.	1		1	4	6

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

2

MP. 1.0 to 1.2

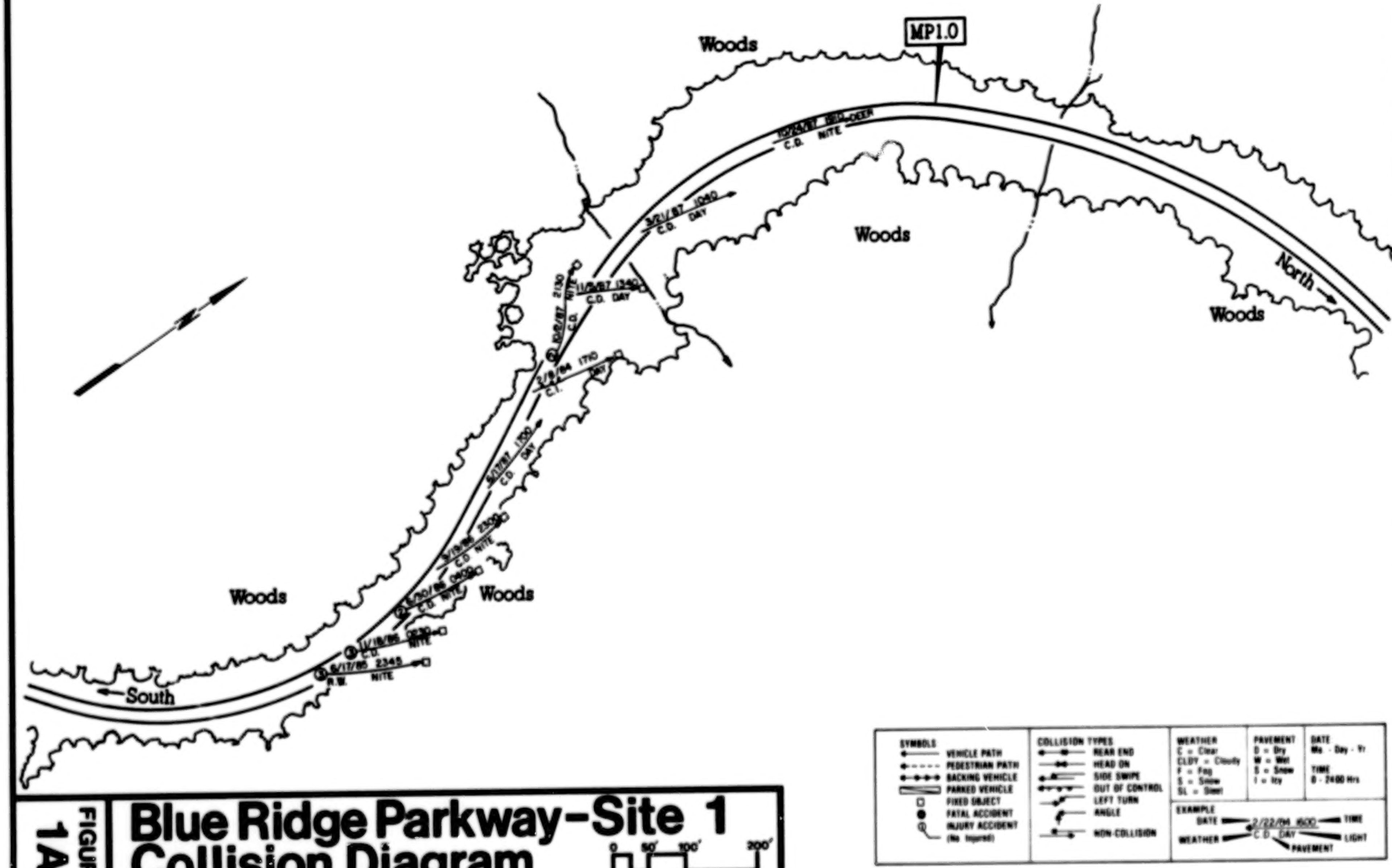


FIGURE 1A

Blue Ridge Parkway-Site 1 Collision Diagram

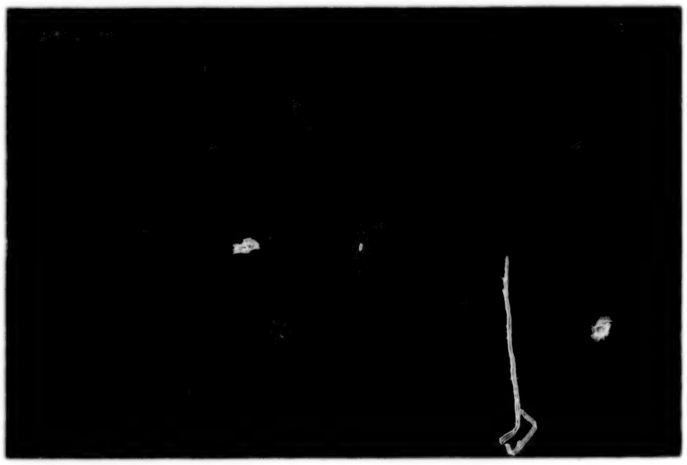
Site Photographs

Photograph 1: Most accidents reported at this site involve northbound vehicles which ran off the road in the curve and struck adjacent trees.

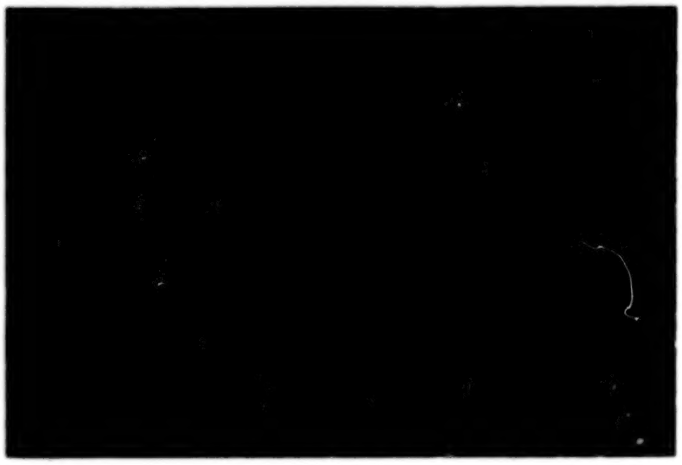
Photograph 2: A double solid yellow centerline is used to prohibit passing through the curve at this site.

Photograph 3: Northbound visitors have no advance warning of the upcoming curves at this site.

Photograph 4: The cut slope on the inside of the curve limits the drivers view of the Parkway's alignment.



Photograph 1



Photograph 2

Photograph 3

Photograph 4

Recommended Improvements

Motorists find it difficult to identify the road alignment as they approach this site, especially at night. The driver's view of the curve is obstructed by the cut slope on the west side of the road. Most accidents at this location were the result of excessive vehicle speed and misjudgement of the curve in the Parkway. The vehicles involved in accidents at the site typically leave the road in the curve and encounter large trees and a steep fill slope. The maximum safe speed for these curves was determined to be 35 mph.

The recommendations presented below address the safety problems and deficiencies at this site.

List of Improvements	Estimated Cost
● Install reverse curve warning signs (W1-4, 30"x30") on both approaches to this site. The warning signs should be accompanied by 35 mph advisory speed plates (W13-1, 18"x18"). Locate these signs as shown in Figure 1B.	$ 600.00
● Remove all vegetation located on the inside of the curve at MP 1.2 that blocks the driver's view of the roadway alignment.	1,000.00
● Install 16 white, flexible delineators along the outside of the curve at MP 1.2. Locate the delineators as shown in Figure 1B. Solid white, flexible delineators similar to those manufactured by Carsonite are recommended because of their high visibility during daylight hours.	800.00
Total Improvement Costs:	**$ 2,400.00**
Benefit/Cost Ratio:	**11.68**

- NPS should monitor the accident history at this location for a 3-year period to determine the effectiveness of the improvements. If a reduction in accidents is not achieved, NPS should consider using chevron warning signs along the outside of the curve.

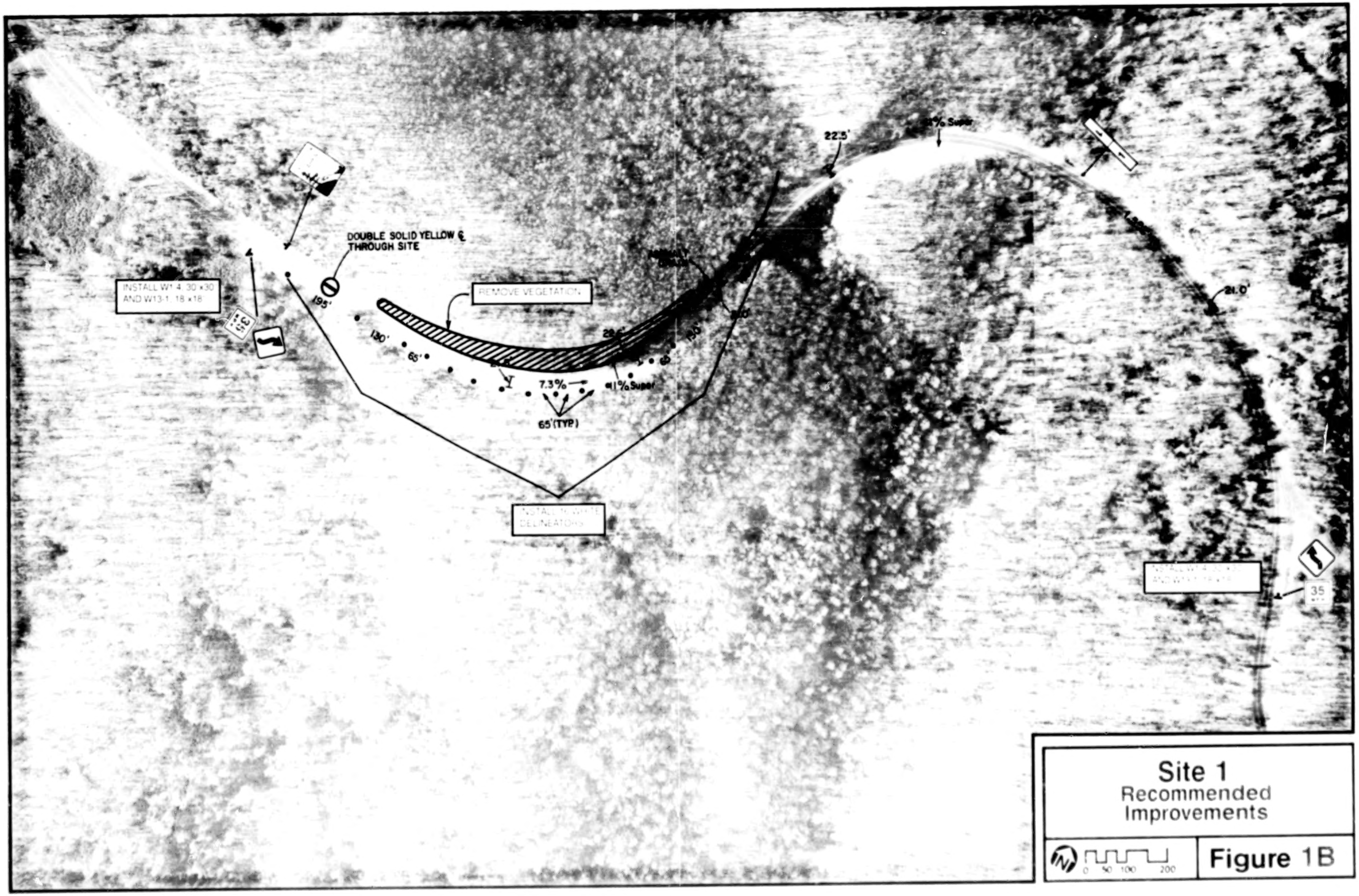
Hazard Index Calculation Form

Site 1: MP 1.0 - 1.2, Curves north of Rockfish Valley Overlook

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	2.5	acc/yr	40.0	x	0.164	=	6.56
Accident Rate	13.61	acc/MVE	100.0	x	0.225	=	22.50
Accident Severity	11,340	dollars	65.0	x	0.191	=	12.42
Sight Distance Ratio	.59	(wt. avg.)	88.0	x	0.074	=	6.51
Driver Expectancy	3.67	(wt. avg.)	61.2	x	0.149	=	9.12
Information System Deficiencies	3.67	(wt. avg.)	61.2	x	0.115	=	7.04

Hazard Index:	64.15
Cost of Recommended Improvements:	$ 2,400.00
Cost Factor:	98

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(64.15 x .75) + (98 x .25) = 72.61



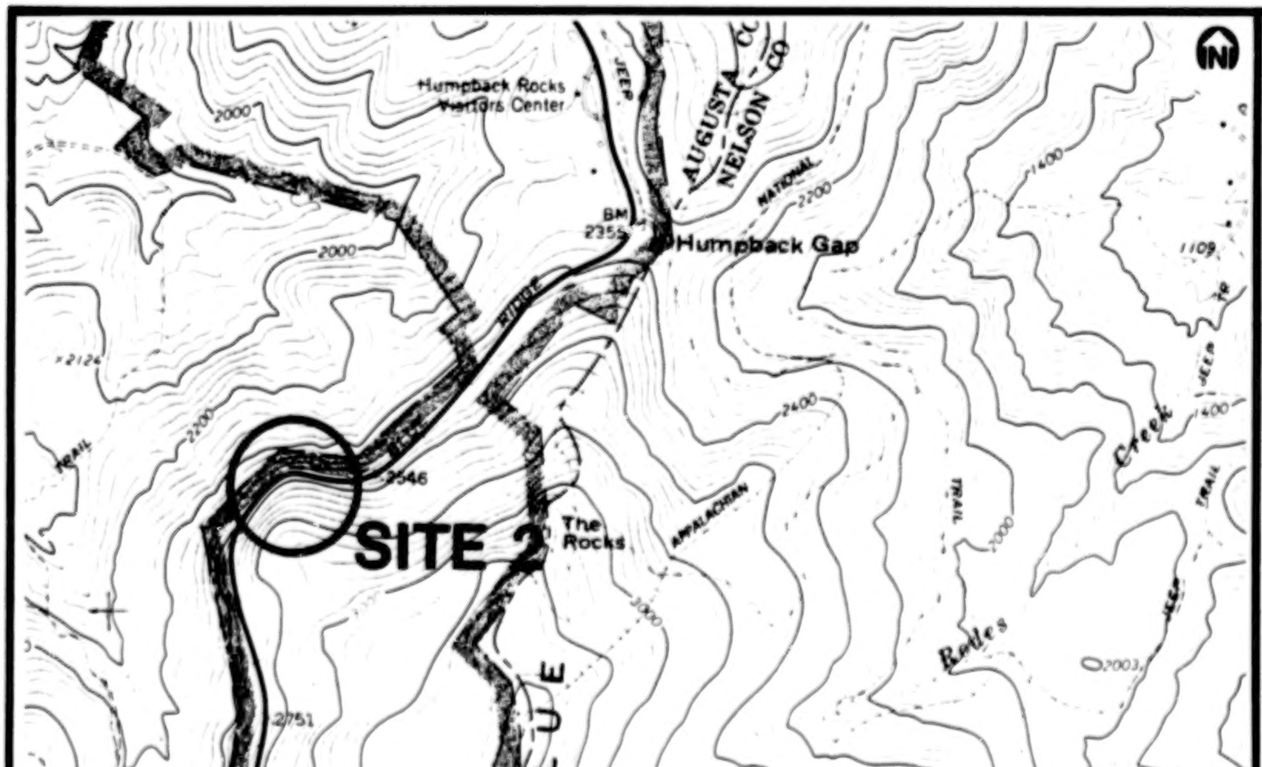
Site 1
Recommended
Improvements

Figure 1B

SITE 2

Existing Conditions

Site 2 is bounded by Mileposts 6.9 and 7.1 and is located between the northern terminus of the Parkway and the NPS facilities at Humpback Rocks. The location of the site is shown on the map following this narrative. The site includes a long "broken-back" curve. A large vertical rock cut slope exists adjacent to the roadway. An 18" high, wooden guiderail has been installed along the west side of the road through much of the site. Grades in this 0.2 mile section of the Parkway are typically 6 to 7% and the curve has a superelevation measured at 10.3%. The width of the Parkway in this site ranges from 21.0 to 22.5 feet. The road has been striped with a double solid yellow centerline through the curve and a curve warning sign (W1-2) with a 35 mph advisory speed plate (W13-1) has been installed at the southern end of the site. The condition of the pavement surface and the centerline striping is generally good. The traffic volume at the site is estimated to be 600 vehicles per day.



Blue Ridge Parkway
MP 6.9 to 7.1

Accident History

Seven accidents occurred at this site during the four-year study period. The locations and pertinent data for each accident are presented in Figure 2A. Five accidents at this site involved single vehicles, including three motorcycle accidents. One of the two multi-vehicle accidents occurred as vehicles sideswiped each other while traveling in opposite directions on the Parkway. The other multi-vehicle accident was a head-on collision which produced four injuries. A total of five injury accidents occurred at this location which injured a total of nine people. The other injury accidents were fixed-object collisions with the vertical rock cut slope or the guiderail located at the site. Five of the accidents happened during clear days on dry pavement. One accident was caused by icy road conditions and one accident occurred during foggy weather. Characteristics of the seven accidents recorded at this site are summarized below.

ACCIDENT DATA

SITE 2: MP 6.9 - 7.1 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
2	2	2	1

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
2			1	1	2	1

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		2	1	1	1				1	1	

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1											1	1		1		1	1						1

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
5	2		

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
5	1		1	

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
6			1

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
		4			1	1	1		

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
3		2	2					

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)	1 (1)	1 (2)	2 (2)	1 (4)	5 (9)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.	1	1			2

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

3

MP. 6.9 to 7.1

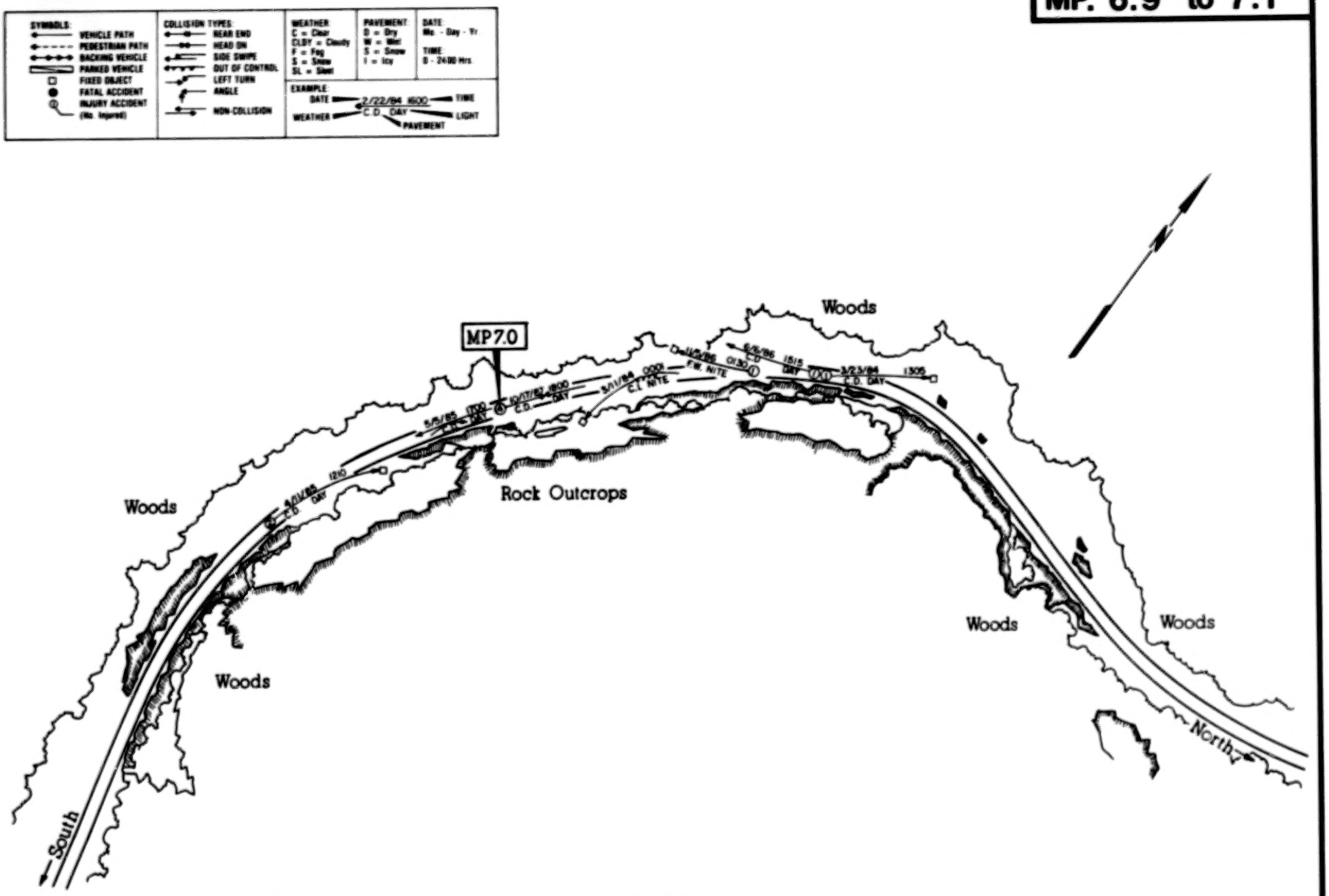


FIGURE 2A

Blue Ridge Parkway–Site 2 Collision Diagram

0 50' 100' 200'
SCALE

Site Photographs

Photograph 1: There is no advance signing on the north approach to this curve. A low, wooden guiderail is located on the outside of the curve.

Photograph 2: The terminal section of the guiderail is located in the curve and constitutes a fixed-object hazard to motorists. Note the "volunteer pullout" adjacent to the end of the guiderail.

Photograph 3: Advance signing for this curve consists only of a non-standard "35 mph" warning sign located on the south approach.

Photograph 4: The vertical rock cut slope on the inside of the curve limits sight distance at this location.

Photograph 1

Photograph 2

Photograph 3

Photograph 4

Recommended Improvements

The existing signing of the curve at this site does not conform to the Manual on Uniform Traffic Control Devices (MUTCD). Proper advance warning signs should be used to identify the conditions ahead. The maximum safe speed for the curve was determined to be 35 mph. Proper signing for these conditions would consist of curve warning signs with 35 mph advisory speed plates placed well in advance of the curve. Another problem has been created at this site by the presence of two "volunteer pullouts" at the south end of the curve. These pullouts are caused by visitors who stop and photograph the view from the rock outcrop. These "volunteer pullouts" are undesirable because of the potential for vehicle conflicts created by motorists stopping in this curve section.

The following recommendations address the safety deficiencies at this site:

List of Improvements	Estimated Cost
● Remove the 35 mph sign located on the south side of this site.	$ 100.00
● Install curve warning signs (W1-2, 30"x30") along with 35 mph advisory speed plates (W13-1, 18"x18") on both approaches to this curve. Place these warning signs 500 feet from the beginning of the curve on both approaches.	600.00
● Extend the guiderail 600 feet to the south of where the existing guiderail ends to eliminate the volunteer pullouts. The entire guiderail should be equipped with 3" white reflectors mounted on the face of the guiderail spaced at 50-foot intervals.	18,000.00
Total Improvement Costs:	**$18,700.00**
Benefit/Cost Ratio:	**1.72**

- **Long-Term Improvement**: Replace the guiderail with a new steel-backed, wooden guardrail.

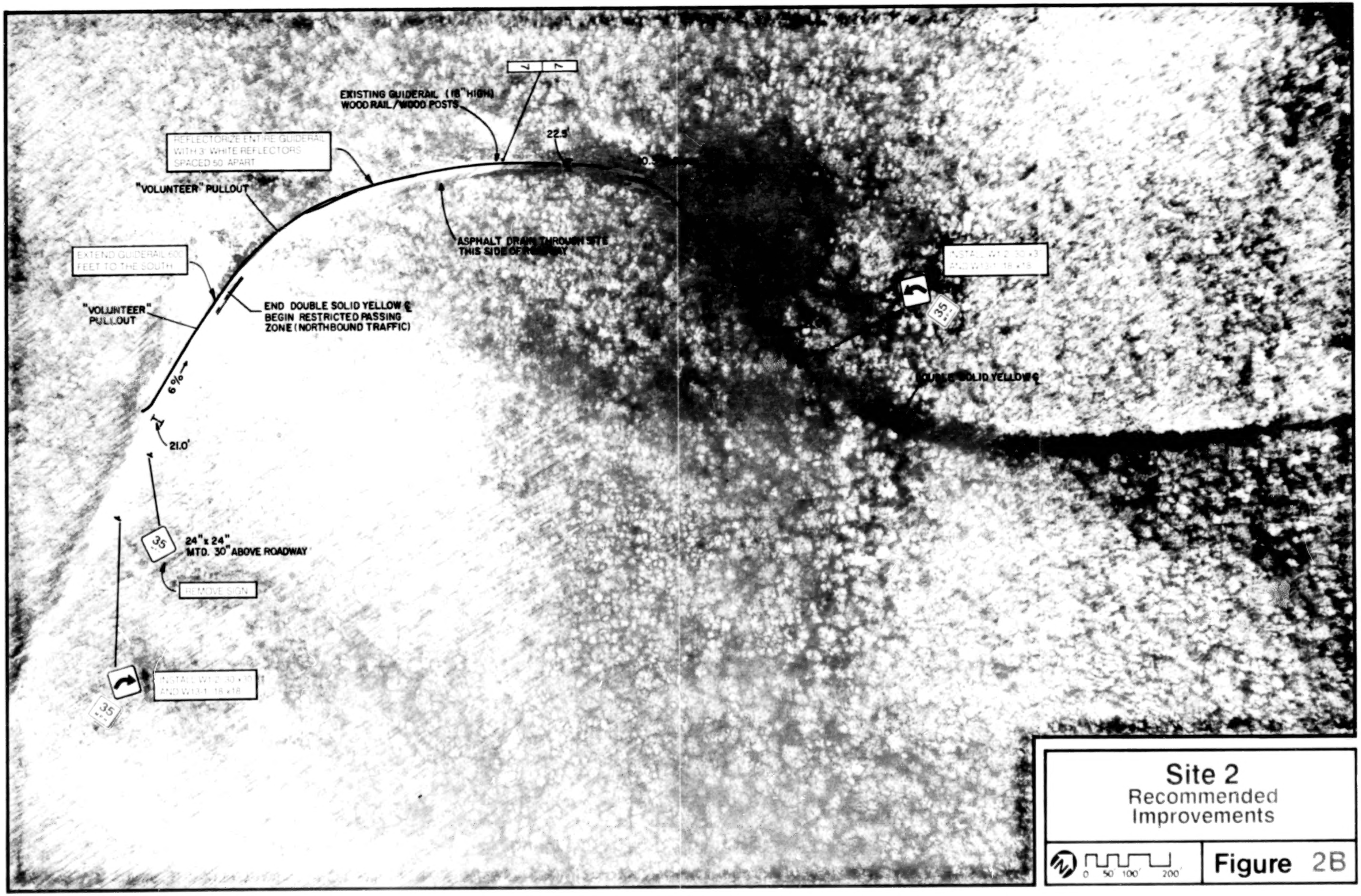
Hazard Index Calculation Form

Site 2: MP 6.9 - 7.1, Curve south of Humpback Gap

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	1.75	acc/yr	35.0	x	0.164	=	5.74
Accident Rate	9.52	acc/MVE	97.0	x	0.225	=	21.83
Accident Severity	14,457	dollars	74.0	x	0.191	=	14.13
Sight Distance Ratio	.97	(wt. avg.)	35.0	x	0.074	=	2.59
Driver Expectancy	4.33	(wt. avg.)	72.2	x	0.149	=	10.76
Information System Deficiencies	5.67	(wt. avg.)	94.5	x	0.115	=	10.87

Hazard Index:	65.92
Cost of Recommended Improvements:	$18,700.00
Cost Factor:	66

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(65.92 x .75) + (66 x .25) = 65.94


EXISTING GUIDERAIL (18" HIGH)
WOOD RAIL/WOOD POSTS
22.5'
10.3'
REFLECTORIZE ENTIRE GUIDERAIL WITH 3" WHITE REFLECTORS SPACED 50' APART
"VOLUNTEER" PULLOUT
ASPHALT DRAIN THROUGH SITE THIS SIDE OF ROADWAY
EXTEND GUIDERAIL 600 FEET TO THE SOUTH
"VOLUNTEER" PULLOUT
END DOUBLE SOLID YELLOW ℄
BEGIN RESTRICTED PASSING ZONE (NORTHBOUND TRAFFIC)
INSTALL W1-2 30 x 30 AND W13-1 18 x 18
35
DOUBLE SOLID YELLOW ℄
6%
21.0'
35
24" x 24"
MTD. 30" ABOVE ROADWAY
REMOVE SIGN
INSTALL W1-2 30 x 30 AND W13-1 18 x 18
35
0
50'
100'
200'

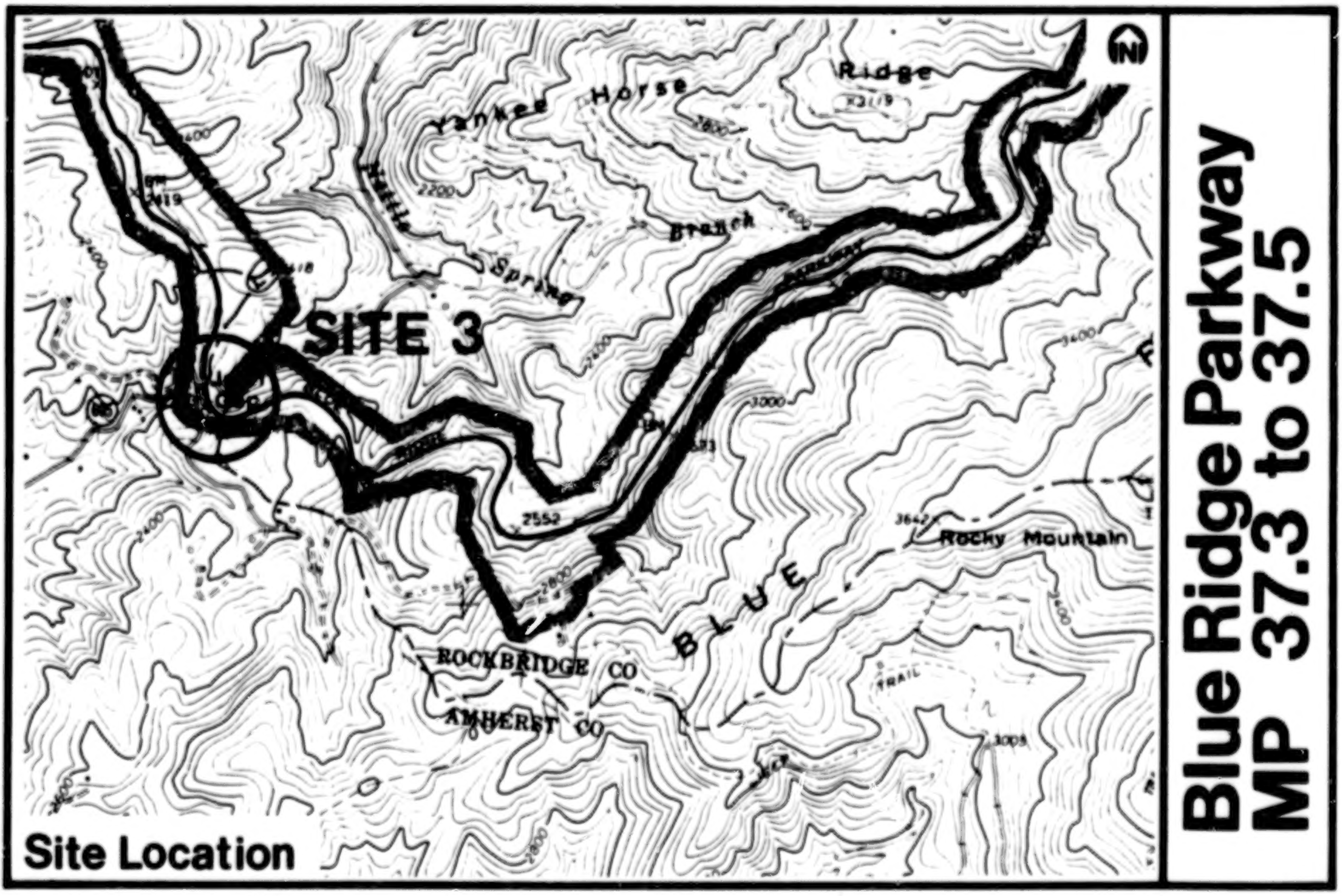
Site 2
Recommended Improvements

Figure 2B

SITE 3

Existing Conditions

This site consists of a three-way, at-grade crossing formed by the intersection of the Parkway and Virginia Secondary Highway 605 at Irish Gap. The site (shown in the map at the bottom of this page) is located between Mileposts 37.3 and 37.5. The site includes a reverse curve and an overpass structure for the Secondary Route. Measured grades on the Parkway ranged from 6 to 7.3% with 10 to 11% superelevations in the curves. The typical widths of the road surface at this location vary from 21.0 feet to 23.0 feet in the curve near the intersection. Curve warning signs with 30 mph advisory speed plates (W1-2/W13-1) are located both north and south of the crossing. Centerline striping prohibits passing through the site. A stop sign controls approach traffic on the Secondary Route. Existing conditions and signing are shown in Figure 3B.



Site Location

Blue Ridge Parkway MP 37.3 to 37.5

Accident History

All nine accidents that occurred at this site involved northbound vehicles which had trouble negotiating the curve. The vehicles involved in seven of the incidents left the road and collided with fixed-objects, usually the cut slope, on the outside of the curve. Four of the accidents at this location resulted in injuries to six people. Only one accident occurred in the rain with the rest happening when conditions were clear and dry. Five of the nine accidents took place during daylight hours. Motorcycles were involved in three of the accidents reported at Site 3. Excessive vehicle speed was a contributing factor in the majority of the accidents. Figure 3A depicts the locations of all accidents that occurred during the study period at this location. A composite summary of all accidents during the study period is shown in the following table.

ACCIDENT DATA

SITE 3: MP 37.3 - 37.5 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
1	1	5	2

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
3			2		3	1

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		1		1	2	2	1	1	1		

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
									1		1		1	1	1		1		1	1			1

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
5	2		2

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
8	1			

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
8	1		

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
		7				2			

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
2	1		6					

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)	1 (1)	1 (1)	1 (3)	1 (1)	4 (6)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.			4	1	5

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

3

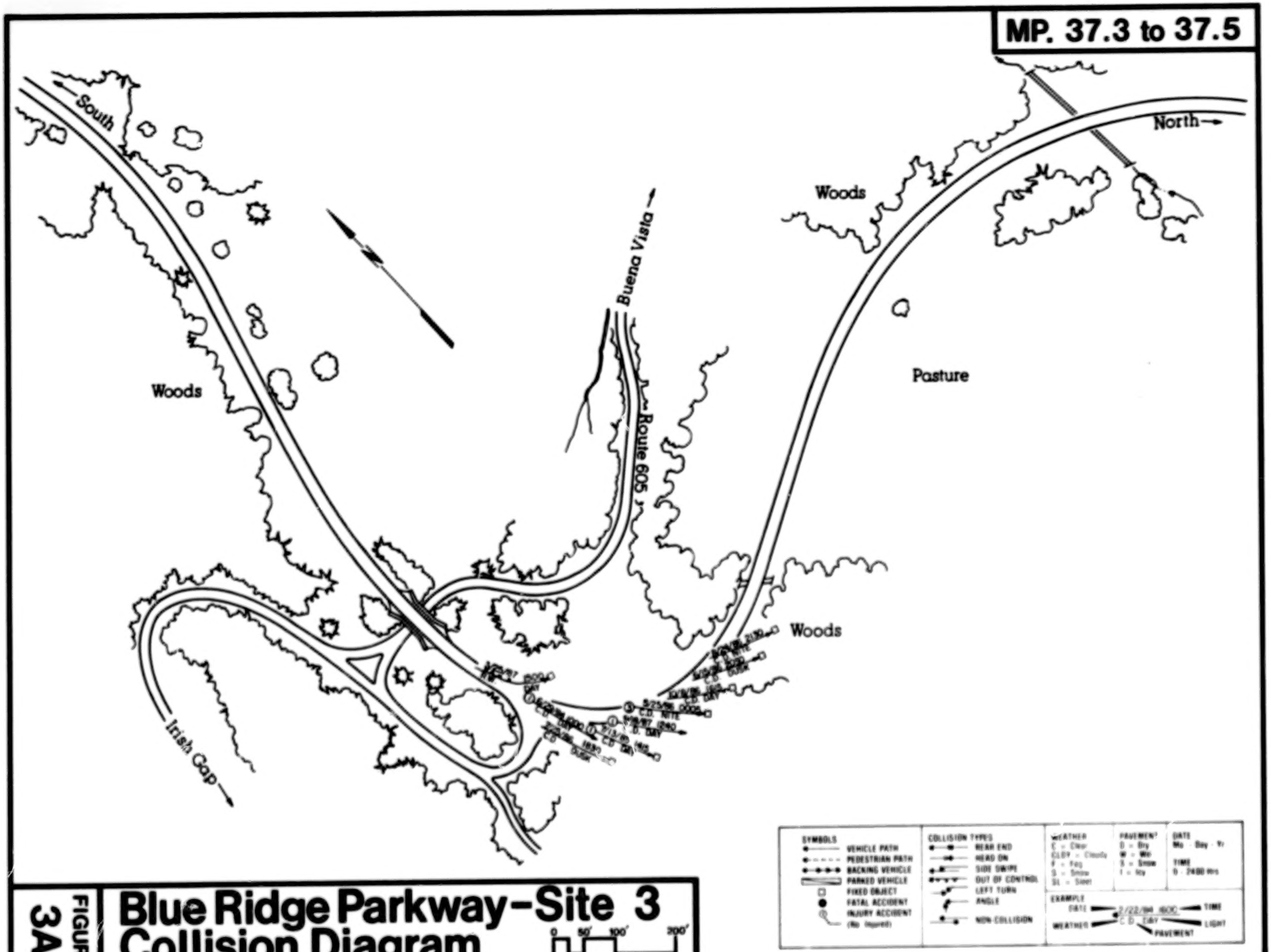


FIGURE 3A

Blue Ridge Parkway–Site 3 Collision Diagram

Site Photographs

Photograph 1: Vegetation growing on the inside of the curve limits the view of the road for motorists entering the Parkway at Irish Gap.

Photograph 2: The access road at this site is controlled by a stop sign. A barricade gate is used to prohibit access to the Parkway during periods of snowy or icy-road conditions.

Photograph 3: Many of the accidents at this site were collisions with fixed-objects as vehicles left the Parkway in the curve north of the intersection.

Photograph 4: A 30"x30" curve warning sign with a 30 mph advisory speed plate are used on both approaches to this site.

Photograph 1

Photograph 2

Photograph 3

Photograph 4

Recommended Improvements

Although there are warning signs on the approaches to this site, motorists still have difficulty negotiating the curve. A vehicle speed study conducted at this site indicated that the average speed is 37 mph, while the maximum safe speed for this curve was determined to be 30 mph. Trees and brush on the inside of the curve also limit sight distance for approaching traffic.

The recommendations listed below address the safety problems and deficiencies at this site:

List of Improvements	Estimated Cost
● Replace the curve warning sign on the north approach with a turn warning sign (W1-1, 30"x30"). The turn warning sign is appropriate for curves with maximum safe speeds of 30 mph and less.	$ 200.00
● The current warning sign south of the site is not producing the desired reduction in vehicle speeds. Replace the curve warning sign on the south approach with an oversized turn warning sign (W1-1, 36"x36"). Replace the existing 30 mph advisory speed plate (18"x18") with a similar sign that is 24"x24" in size.	500.00
● Install 22 white bi-directional flexible delineators along the outside of the curve and space them as shown in Figure 3B. Solid white, flexible delineators are recommended because of their high visibility during daylight hours.	1,100.00
● Remove all trees and shrubs on the inside of this curve that limit the driver's view of the roadway alignment.	3,000.00
● Relocate the "No Commercial Vehicles" sign to a position adjacent to the barricade gate.	200.00
● Replace the existing 24" x24" "Barricade Ahead" warning sign with a 48"x48" warning sign.	200.00
● Install a painted stop bar on the pavement adjacent to the stop sign at this intersection.	200.00
Total Improvement Costs:	**$ 5,400.00**
Benefit/Cost Ratio:	**3.72**

- NPS should monitor the accident history at this site for a 3-year period to determine the effectiveness of the improvements. If a reduction in accidents is not achieved, the NPS should consider the use of chevron warning signs along the outside of the curve.

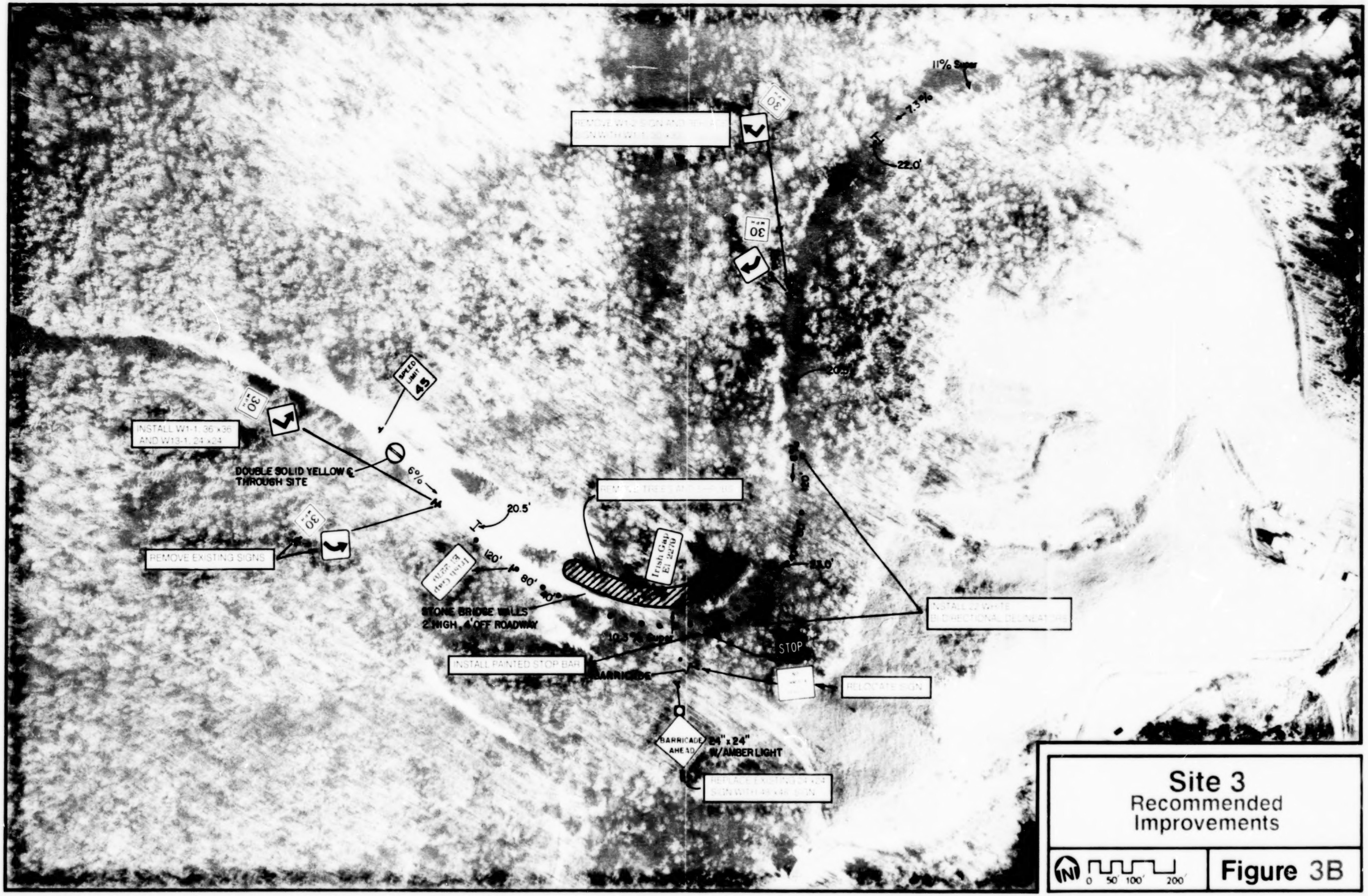
Hazard Index Calculation Form

Site 3: MP 37.3 - 37.5, Irish Gap

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	2.25	acc/yr	38.0	x	0.164	=	6.23
Accident Rate	21.01	acc/MVE	100.0	x	0.225	=	22.50
Accident Severity	12,400	dollars	69.0	x	0.191	=	13.18
Sight Distance Ratio	.92	(wt. avg.)	39.0	x	0.074	=	2.89
Driver Expectancy	1.5	(wt. avg.)	25.0	x	0.149	=	3.73
Information System Deficiencies	2.0	(wt. avg.)	33.3	x	0.115	=	3.83

Hazard Index:	52.36
Cost of Recommended Improvements:	$5,400.00
Cost Factor:	82

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(52.36 x .75) + (82 x .25) = 59.77

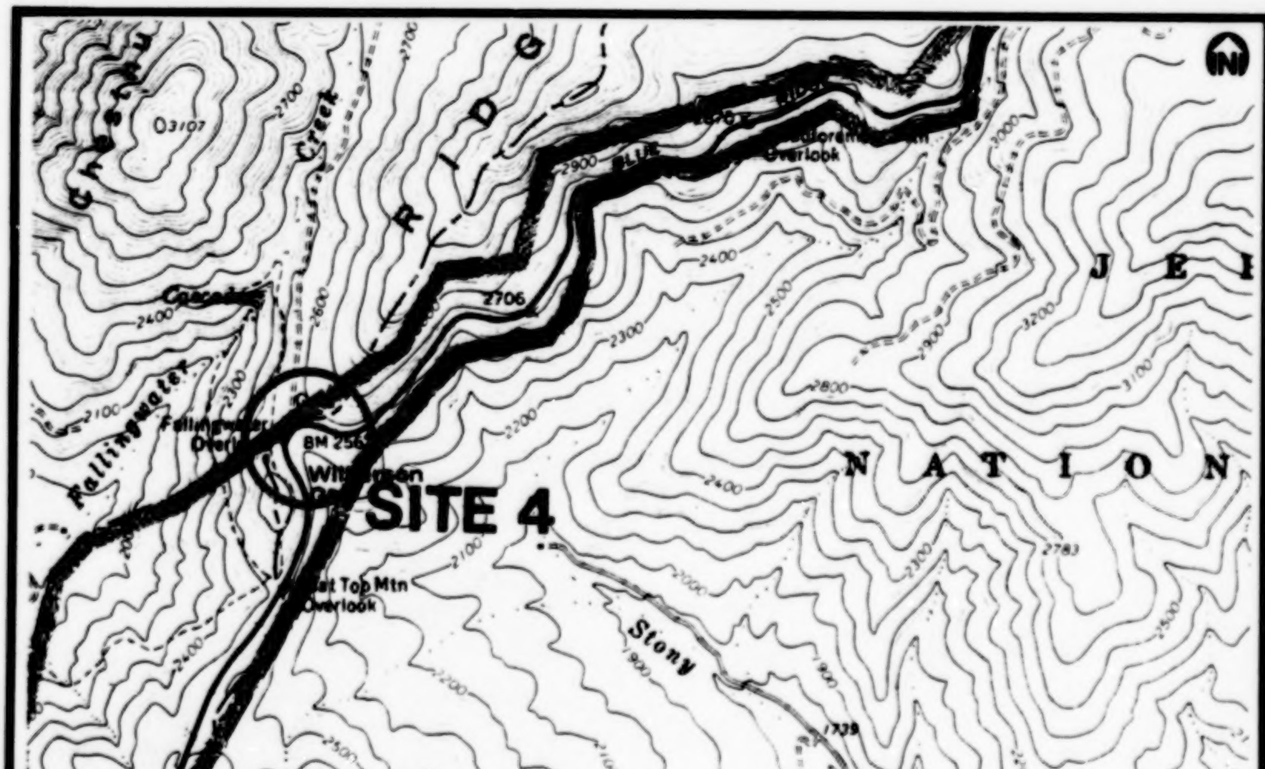


Site 3
Recommended
Improvements

Figure 3B

SITE 4
Existing Conditions

Site 4 (shown on the following map) consists of a set of curves located between Mileposts 82.9 and 83.1 some three miles north of the Peaks of Otter. The parking area for the Fallingwater Cascades loop trail is located within the site. The grades on this section of road were measured at 4% with superelevations in the curve near the accesses to the parking area ranging from 10.5% to 12.3%. Road widths in the site vary from 21.0 to 24.0 feet. The entire site has been marked with a double solid yellow centerline to prohibit passing. A reverse curve sign with a 30 mph advisory speed plate has been installed north of the parking area. Yield signs control traffic leaving the parking area. The condition of the pavement and all signs and markings is good.



Site Location

Blue Ridge Parkway
MP 82.9 to 83.1

Accident History

Eight accidents occurred at this location during the four-year study period. All accidents at this site are shown in Figure 4A. Two distinct types of accidents, animal/vehicle collisions and run-off-the-road incidents by motorcycles, took place at this site. Four accidents at this site involved deer collisions in the fog during low-light conditions. The other four accidents occurred as southbound motorcyclists lost control and left the road in the curve. These incidents happened on clear days and on dry pavement. Excessive vehicle speed contributed to all of the motorcycle accidents. Two such accidents produced injuries to the operator. The remainder were property-damage-only accidents. The characteristics of all study period accidents are summarized below.

ACCIDENT DATA

SITE 4: MP 82.9 - 83.1 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
	4	3	1

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
1	2			1	3	1

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		1		2	1			2	1	1	

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
					1							1		1			2	2				1	

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
4	2	1	1

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
4	4			

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
4			4

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
				4		4			

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
4			4					

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)		1 (1)	1 (1)		2 (2)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.		3	2	1	6

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

4

MP. 82.9 to 83.1

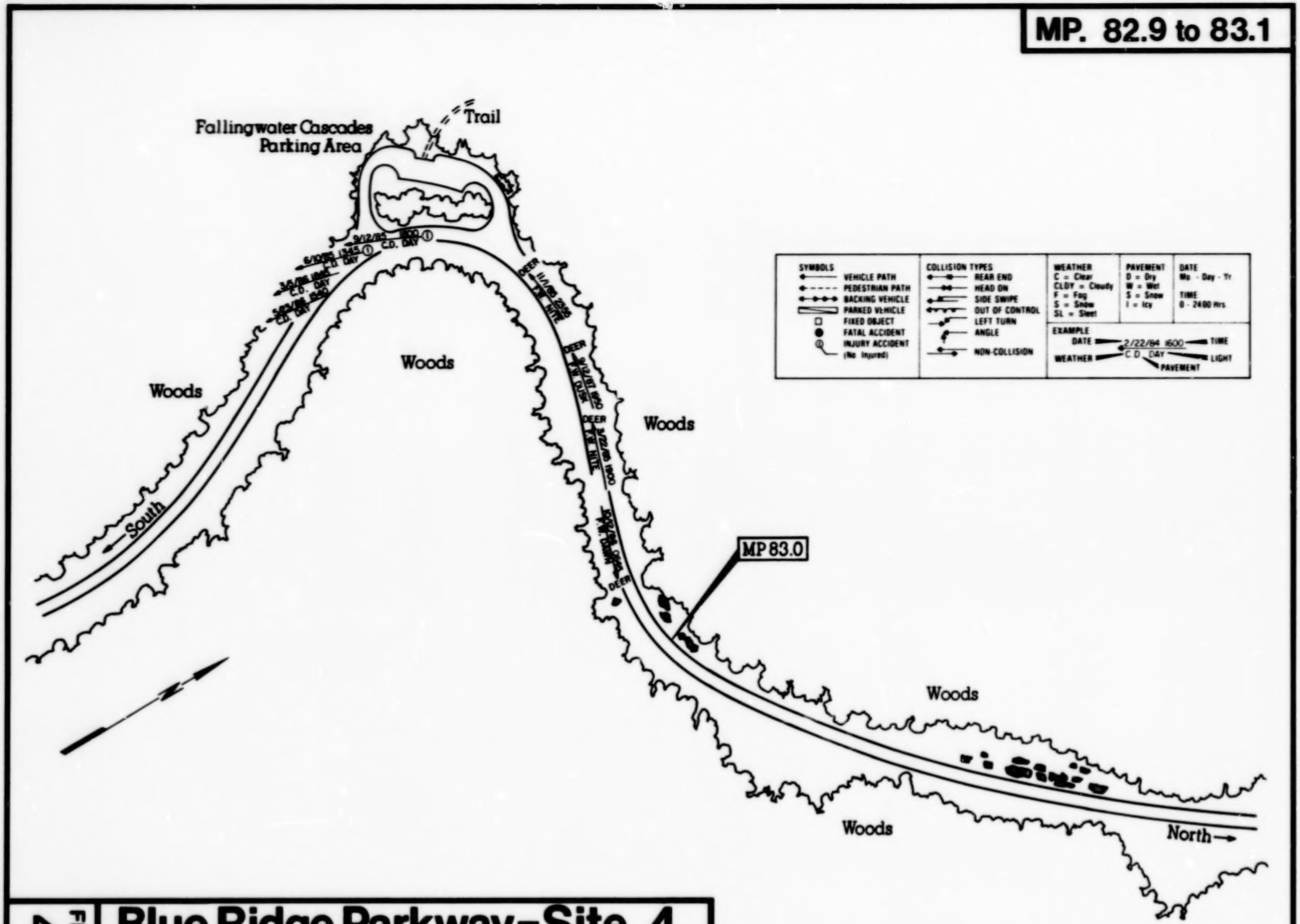


FIGURE 4A

Blue Ridge Parkway-Site 4 Collision Diagram

Site Photographs

Photograph 1: The reverse curve warning sign and 30 mph advisory speed plate located on the north approach are the only warning signs that exist at the site.

Photograph 2: The accesses to the Fallingwater Cascades Parking Area are located in the midst of a sharp curve in the Parkway's alignment.

Photograph 3: The run-off-the-road accidents at this site generally involve southbound motorists that leave the road and strike the cut slope located just south of the accesses to the parking area.

Photograph 4: The view of the Parkway's alignment for northbound motorists is obscured by trees growing on the inside of the curve.

Photograph 1

Photograph 2

Photograph 3

Photograph 4

Recommended Improvements

The sharp curve at this site has not been adequately signed to warn motorists of the conditions ahead. The trees on the inside of the curve also make it difficult to identify the change in alignment at this site. The results of a vehicle speed study conducted at this location indicated that the average speed is 35 mph while the maximum safe speed for the curve was determined to be 25 mph. Loose gravel along the outside edge of the curve may have been a factor in some of the accidents involving motorcycles.

The recommendations presented below address the safety problems at this site:

List of Improvements	Estimated Cost
● Remove the existing reverse curve sign located on the north approach to this site.	$ 100.00
● Install "Sharp Curve" warning signs (W1-5A, 36"x36") approximately 300 feet from the curve on both approaches. Mount speed plates (W13-1, 18"x18") below the curve warning signs to advise a speed of 25 mph.	800.00
● Install 18 white bi-directional flexible delineators in the curve as shown in Figure 4B. Solid white, flexible delineators similar to those manufactured by Carsonite are recommended because of their high visibility during daylight hours.	900.00
● Remove the trees on the inside of the curve that obscure the motorist's view of the road alignment.	5,000.00
● Relocate the "Overlook Ahead" sign on the south approach to 750 feet south of the parking area.	300.00
● Install an "Overlook Ahead" sign 800 feet north of the Fallingwater Cascades parking area.	200.00
● Remove the loose gravel from the pavement and immediate shoulder area in the curve at this site. If a drop-off adjacent to the pavement edge is created, the shoulder should be re-established to grade.	200.00
● Replace the 24"x24"x24" yield signs with 30"x30"x30" yield signs.	600.00
Total Improvement Costs:	**$ 8,100.00**
Benefit/Cost Ratio:	**1.55**

- NPS should monitor the accident history at this location for a 3-year period to determine the effectiveness of the improvements. If a reduction in accidents is not achieved, NPS should consider the use of directional arrows or chevron warning signs on the outside of the curve.

Hazard Index Calculation Form

Site 4: MP 82.9 - 83.1, Curve at Fallingwater Cascades Parking Area

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	2.0	acc/yr	37.0	x	0.164	=	6.07
Accident Rate	17.36	acc/MVE	100.0	x	0.225	=	22.50
Accident Severity	7,100	dollars	54.0	x	0.191	=	10.31
Sight Distance Ratio	1.08	(wt. avg.)	28.0	x	0.074	=	2.07
Driver Expectancy	4.5	(wt. avg.)	75.0	x	0.149	=	11.18
Information System Deficiencies	5.5	(wt. avg.)	91.7	x	0.115	=	10.55

Hazard Index:	62.68
Cost of Recommended Improvements:	$8,100.00
Cost Factor:	78

Priority Index = (Hazard Index x .75(+ (Cost Factor x .25)
(62.68 x .75) + (78 x .25) = 66.51

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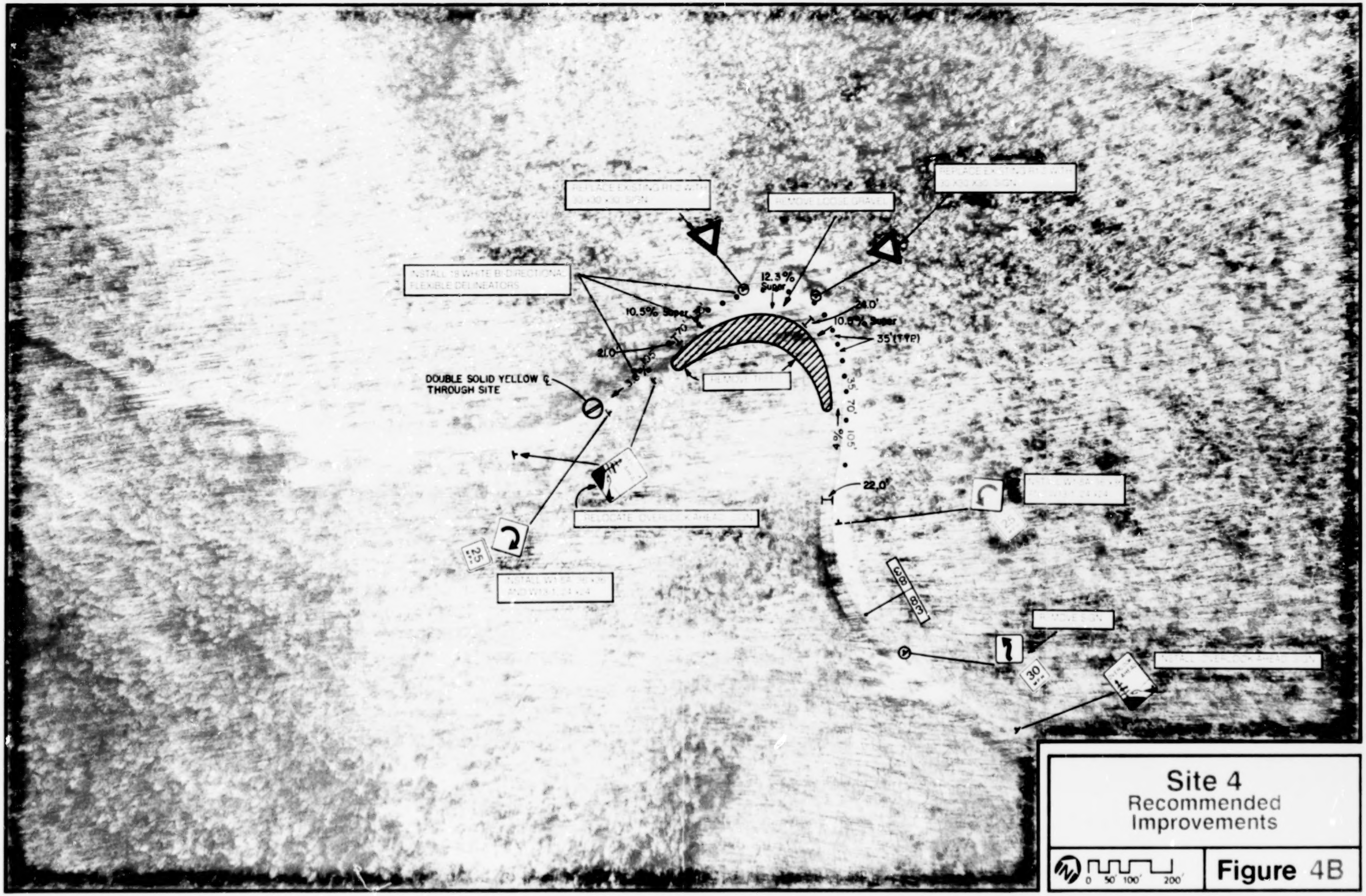


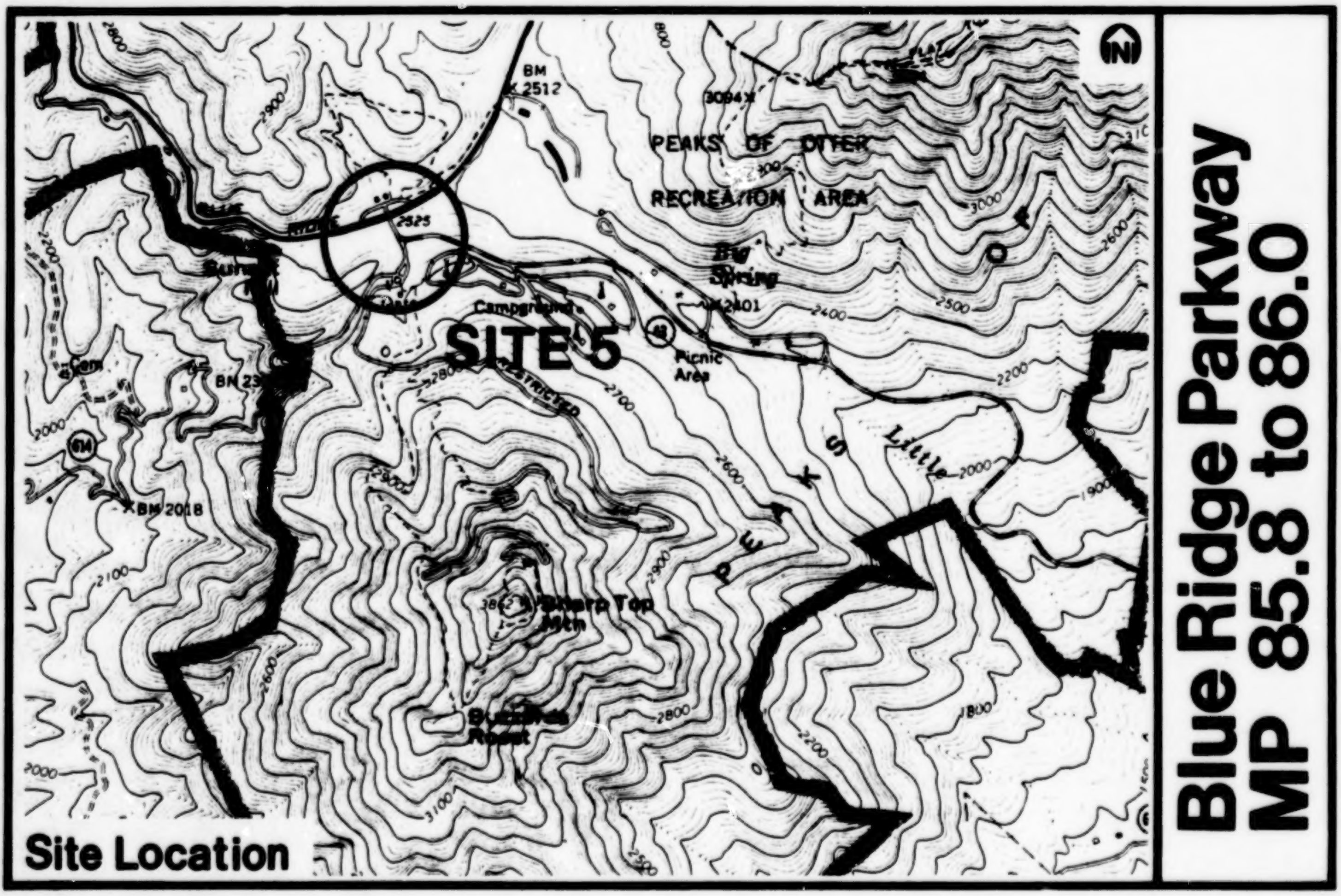
Site 4
Recommended
Improvements

Figure 4B

SITE 5

Existing Conditions

This site consists of the three-way, at-grade intersection formed by the junction of the Parkway and Virginia Primary Highway 43 at the Peaks of Otter. This area is one of the primary recreational, camping, and picnic areas along the northern portion of the Parkway. This site is located within a reduced speed zone with a posted speed limit of 35 mph for both north and southbound traffic. The site is located at Milepost 86.0 and is shown on the map below. The traffic on the Parkway is divided by a turf median that is broken in several locations to allow motorists to access the Peaks of Otter Visitor Center, a gas station/gift shop, and Primary Route 43. Striping through the site delineates two travel lanes for each direction to accommodate necessary traffic movements. Thirty-seven signs have been installed at this intersection to provide guidance and information to visitors. All existing conditions and signing are shown in Figure 5B. The figure also presents the results of the turning movement count conducted at the intersection of the Parkway and State Route 43.



Accident History

The Parkway junction with Primary Route 43 at the Peaks of Otter was the scene of twenty-three accidents during the four-year study period. The accident locations are widely distributed throughout the site and are shown in Figure 5A. Six accidents were partially caused by confusion on the part of the driver as to the layout of the intersection. One case involving driver confusion resulted in a head-on collision when a southbound motorist mistakenly drove down the northbound side of the median island. The majority of the accidents took place during the day when conditions were clear and dry. Only three of the twenty-three reported accidents resulted in injuries to the vehicle's occupants. The composite characteristics of the twenty-three accidents reported at Site 5 during the study period are shown below.

ACCIDENT DATA

SITE 5: MP 85.8 - 86.0 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
3	6	6	8

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
7	2	3	6	1	1	3

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	2			1	4	4	1	1	1	7	1

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
				1	1		1			1	1	3	1	3	3	1	3		1	1		1	1

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
15	7	1	

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
20	2		1	

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
21	2		

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
1	1	7		5		4	1	3	1

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
10		5	3	1		4		

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)			2 (3)	1 (1)	3 (4)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.	3	6	4	7	20

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

3

MP. 85.8 to 86.0

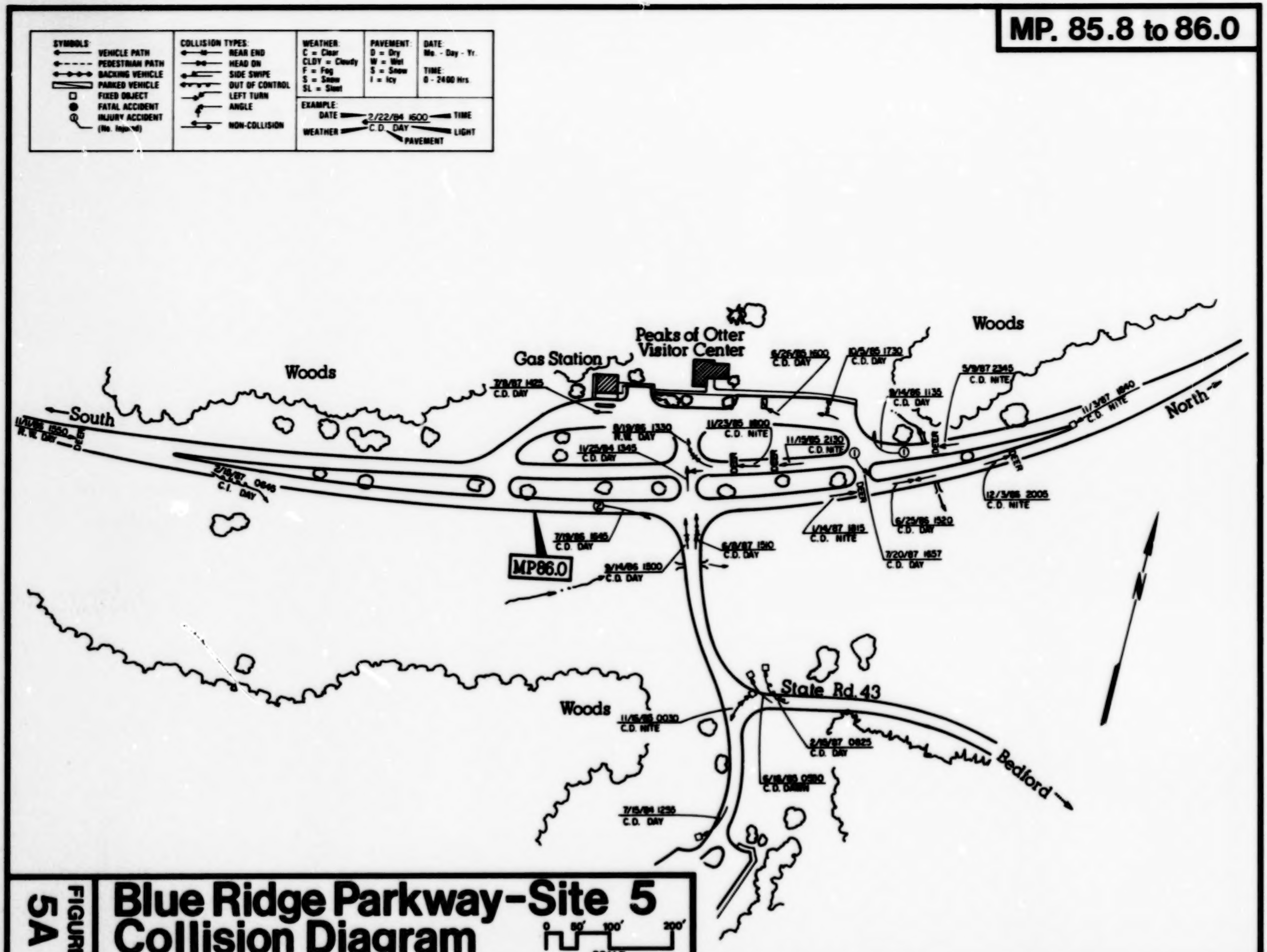


FIGURE 5A

Blue Ridge Parkway-Site 5
Collision Diagram

0 50' 100' 200'
SCALE

Site Photographs

Photograph 1: The Parkway changes from a two-lane road to a divided four-lane highway in this site. A "Keep Right" sign is located on the end of the median to warn motorists of this change.

Photograph 2: Trees and shrubs on the median are sight distance obstructions during summer months. Note that the Parkway has two northbound and two southbound lanes in this location, but no lane-use signs or pavement markings are used to identify desired traffic movements.

Photograph 3: This photograph shows the intersection of the Parkway and State Route 43. The access road to the camp store parking lot is in the foreground.

Photograph 4: The multiple access points to the Visitor Center and gas station combined with the wide median produces a confusing geometric layout for this intersection.

Photograph 1

Photograph 2

Photograph 3

Photograph 4

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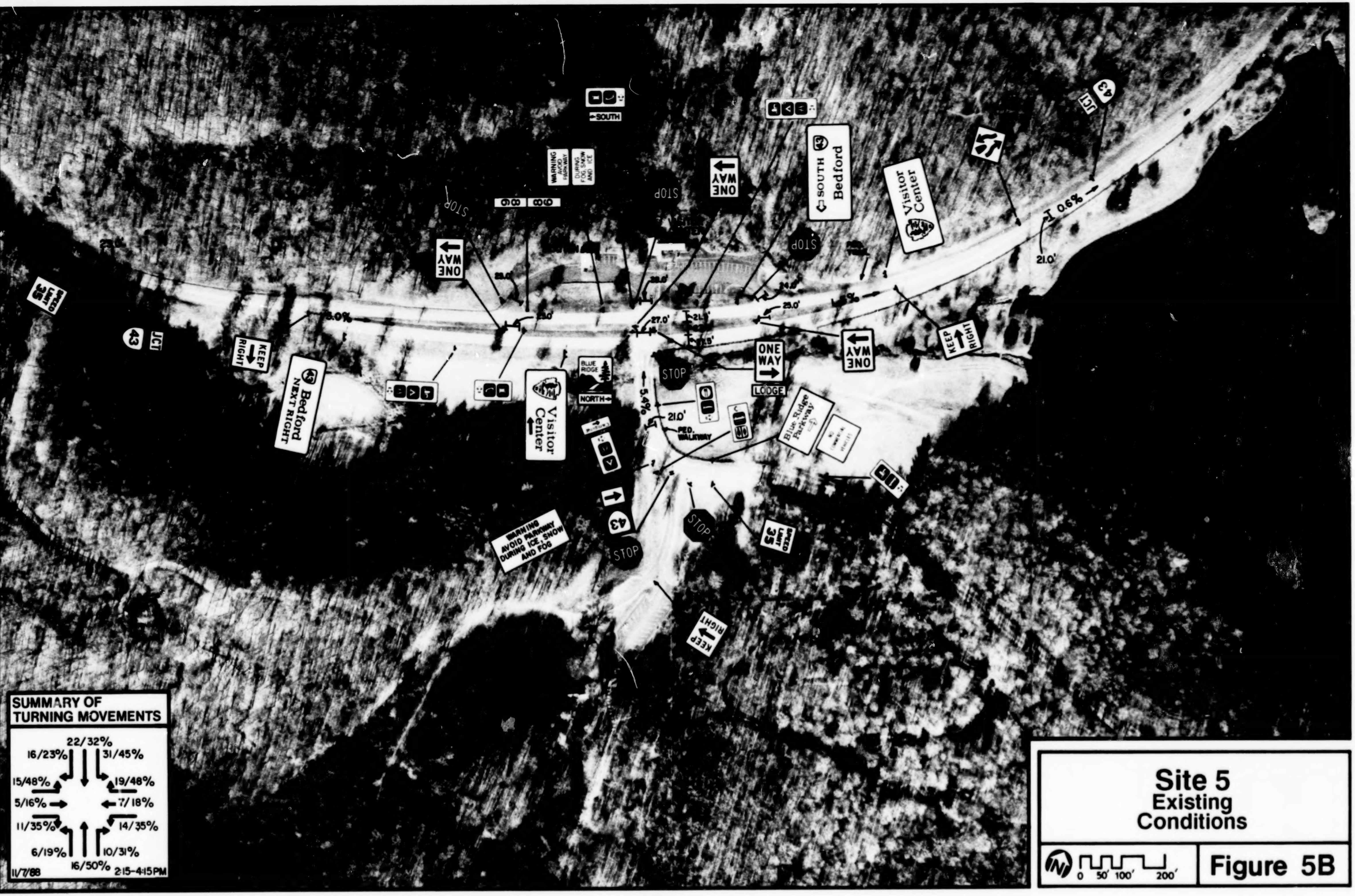


Site 5
Existing Conditions

Figure 5B

Recommended Improvements

The junction of Virginia Primary Route 43 at the Peaks of Otter is confusing to many Parkway visitors. A vehicle conflict study conducted at this location indicated that 17% of all vehicles that enter this site are confused by its signing or layout. The divided road and the multiple access points to the visitor center and gas station provide numerous opportunities for visitors to make driving errors. This site should be modified to simplify the intersection geometrics and minimize signing.

The recommended improvements below address the safety problems at this site:

List of Improvements	Estimated Cost
• Remove the trees and shrubs from the turf median islands.	$ 2,000.00
• Remove the paved gaps in the turf median located north and south of the main intersections with Route 43. Remove the asphalt paving and replace it with turf.	8,000.00
• Eliminate the north and south access points to the visitor center and gas station. Modify the geometrics of the parking area in the vicinity of the gas station to provide adequate traffic circulation around the fueling area as shown in Figure 5C.	100,000.00
• Restripe the Parkway approaches to this intersection to provide a single through/right lane and a left turn lane. Use painted arrows on the pavement to identify the desired lane usage.	2,000.00
• Revise the signing at this intersection as shown on Figure 5C.	3,000.00
Total Improvement Costs:	**$115,000.00**
Benefit/Cost Ratio:	**0.68**

- **Long-Term Improvement**: Consideration should be given to relocating the visitor center, gas station, and amphitheater to the east side of the Parkway. One possible site for the development would be the wooded knoll southeast of the intersection. The primary access to a new development would be from Route 43. The consolidation of facilities would eliminate pedestrian and vehicle conflicts at the intersection. This facility relocation would allow for a standard "T" intersection on the Parkway. Pedestrian underpasses should be utilized where necessary.

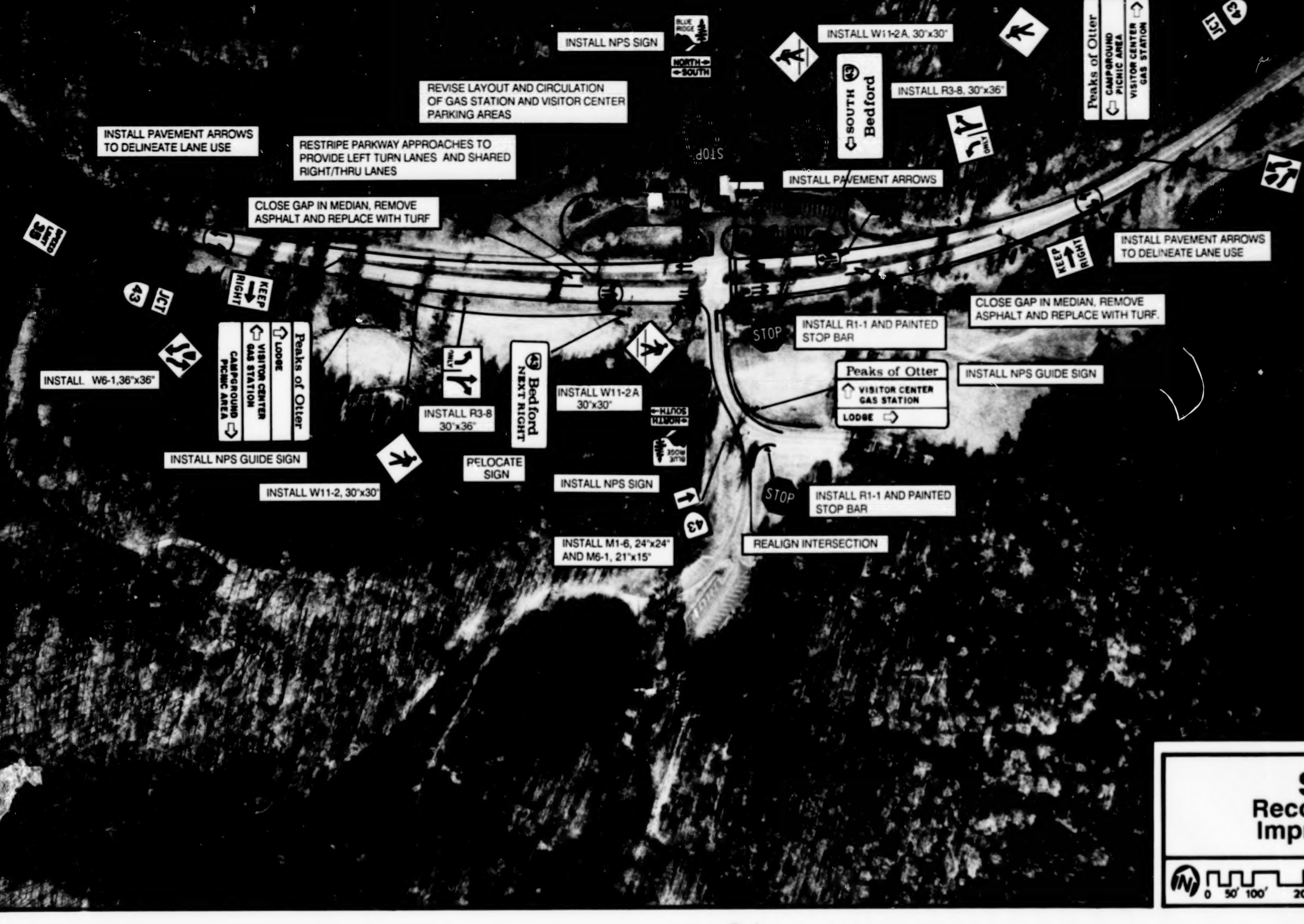
Hazard Index Calculation Form

Site 5: MP 85.8 - 86.0, Peaks of Otter

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	5.75	acc/yr	61.0	x	0.164	=	10.00
Accident Rate	28.22	acc/MVE	100.0	x	0.225	=	22.50
Accident Severity	7,478	dollars	55.0	x	0.191	=	10.51
Sight Distance Ratio	1.25	(wt. avg.)	18.0	x	0.074	=	1.33
Driver Expectancy	5.67	(wt. avg.)	94.5	x	0.149	=	14.08
Information System Deficiencies	5.33	(wt. avg.)	88.8	x	0.115	=	10.21

Hazard Index:	68.63
Cost of Recommended Improvements:	$115,000.00
Cost Factor:	10

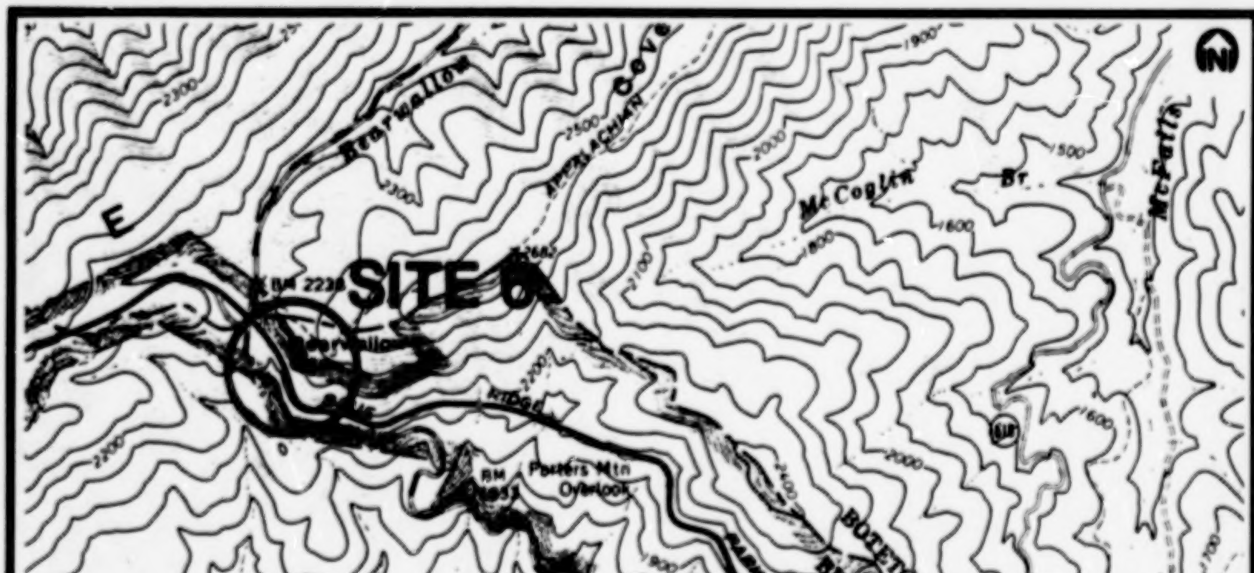
Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(68.63 x .75) + (10 x .25) = 53.97


INSTALL NPS SIGN
BLUE RIDGE
NORTH
SOUTH
INSTALL W11-2A, 30"x30"
Peaks of Otter
CAMPGROUND
PICNIC AREA
VISITOR CENTER
GAS STATION
JCT
43
REVISE LAYOUT AND CIRCULATION OF GAS STATION AND VISITOR CENTER PARKING AREAS
SOUTH
43
Bedford
INSTALL R3-8, 30"x36"
ONLY
INSTALL PAVEMENT ARROWS TO DELINEATE LANE USE
RESTRIPE PARKWAY APPROACHES TO PROVIDE LEFT TURN LANES AND SHARED RIGHT/THRU LANES
STOP
INSTALL PAVEMENT ARROWS
CLOSE GAP IN MEDIAN, REMOVE ASPHALT AND REPLACE WITH TURF
INSTALL PAVEMENT ARROWS TO DELINEATE LANE USE
KEEP RIGHT
43
JCT
KEEP RIGHT
CLOSE GAP IN MEDIAN, REMOVE ASPHALT AND REPLACE WITH TURF.
STOP
INSTALL R1-1 AND PAINTED STOP BAR
Peaks of Otter
LODGE
VISITOR CENTER
GAS STATION
CAMPGROUND
PICNIC AREA
ONLY
43
Bedford
NEXT RIGHT
Peaks of Otter
VISITOR CENTER
GAS STATION
LODGE
INSTALL NPS GUIDE SIGN
INSTALL W6-1,36"x36"
INSTALL W11-2A 30"x30"
INSTALL R3-8 30"x36"
SOUTH
NORTH
BLUE RIDGE
INSTALL NPS GUIDE SIGN
RELOCATE SIGN
INSTALL NPS SIGN
INSTALL W11-2, 30"x30"
STOP
INSTALL R1-1 AND PAINTED STOP BAR
43
INSTALL M1-6, 24"x24" AND M6-1, 21"x15"
REALIGN INTERSECTION
S
Reco
Impr
N
0 50' 100' 20

SITE 6

Existing Conditions

This site consists of a set of curves located between Mileposts 90.7 and 90.9 just north of the interchange providing access to Virginia Primary Highway 43/Secondary Highway 695 at Bearwallow Gap. The site's location (approximately 5 miles south of the Peaks of Otter) is shown below. The width of the Parkway varies from 20.0 feet to 24.0 feet within the site. Grades were measured at between 4.6 and 6.5%. The entire site has been marked with a double solid yellow centerline to prohibit passing. A curve warning sign with a 35 mph advisory speed plate (W1-2/W13-1) has been placed near the south end of the site for northbound motorists. The overall condition of the site's pavement surface, signing, and markings is good. The traffic volume on this section of the Parkway is estimated to be 380 vehicles per day.



Site Location

Blue Ridge Parkway MP 90.7 to 90.9

Accident History

Six accidents occurred at this location during the four-year study period. Figure 6A presents the collision diagram for all accidents at this site. Three of these accidents involved northbound motorcycles that left the road in the curve. Two such accidents resulted in injuries to the operator of the motorcycle. There were two multi-vehicle incidents. One of the multi-vehicle accidents at this location occurred when two vehicles sideswiped each other as they met, and the other was a head-on collision in the curve. The head-on collision caused injuries to four people. One accident at this site was the result of a collision with a deer. All of the accidents at Site 6 happened when the weather was clear and the pavement was dry. Only two of the six accidents reported at this location occurred at night. A summary of all accident characteristics is presented below.

ACCIDENT DATA

SITE 6: MP 90.7 - 90.9 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
2	3	1	

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
2			2	1		1

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			1		1			1	2		1

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
				1								2	2					1					

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
4	2		

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
6				

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
6			

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
		1		1	1	2	1		

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
1	1	2	2					

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)	1 (4)	2 (2)			3 (6)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.	1	1	1		3

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

3

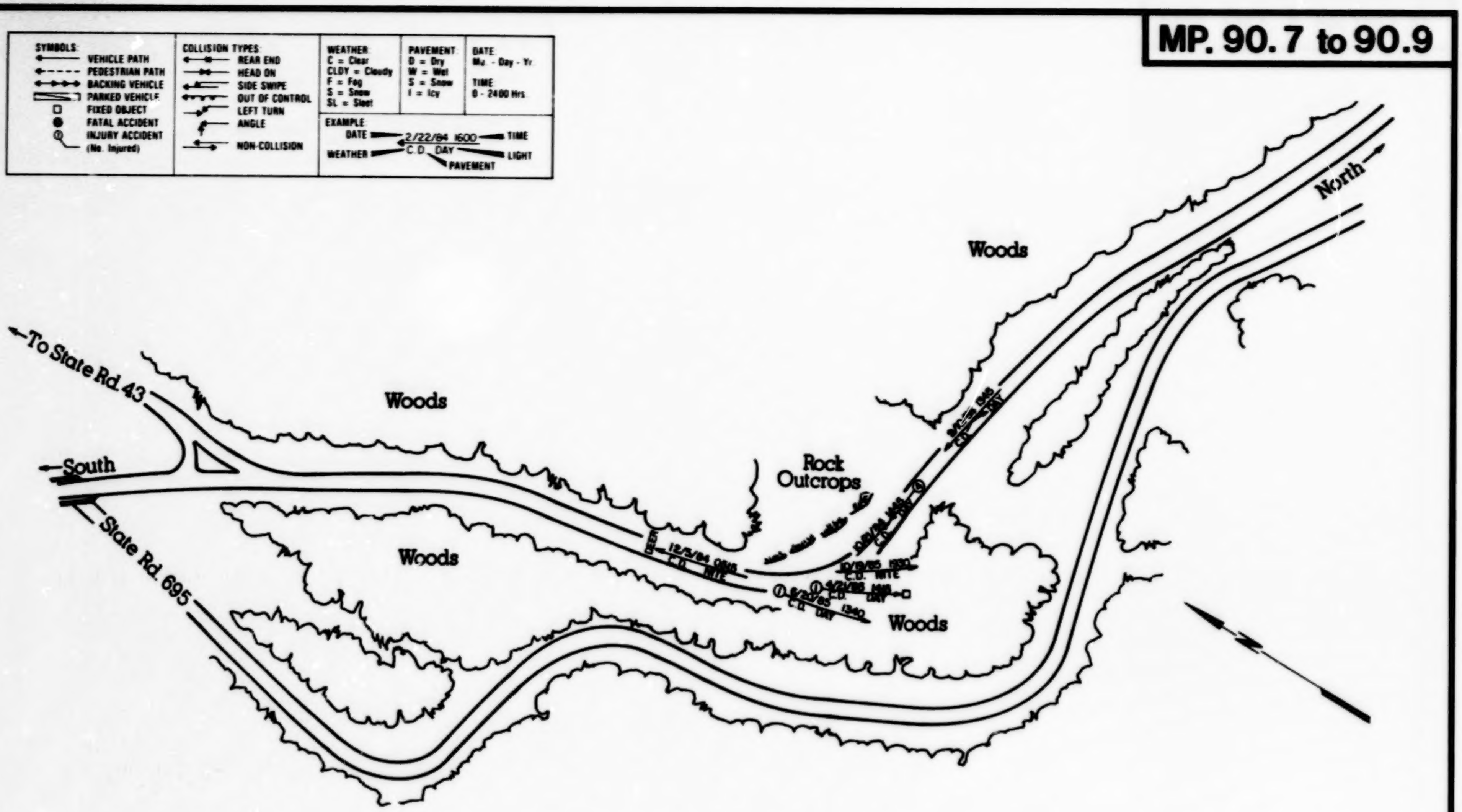


FIGURE 6A

Blue Ridge Parkway-Site 6 Collision Diagram

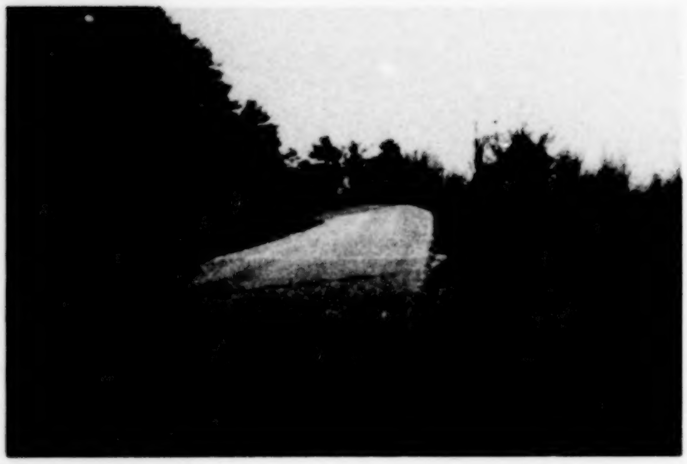
Site Photographs

Photograph 1: The curve warning sign and 30 mph advisory speed plate located on the south approach are the only warning signs used at the site.

Photograph 2: The vertical rock cut slope adjacent to the Parkway limits sight distance in the sharp curve.

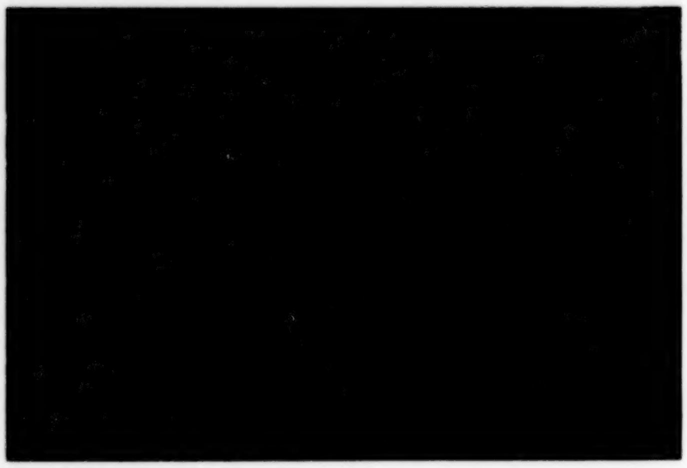
Photograph 3: The shoulder of the Parkway is heavily worn on the outside of the curve even though the road has been widened to 24 feet.

Photograph 4: This view from the north approach shows the steep fill slope located on the east side of the Parkway.

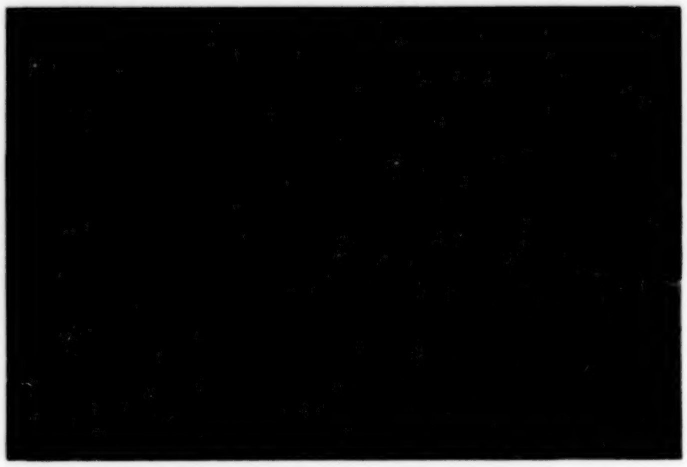


Photograph 1

Photograph 2



Photograph 3



Photograph 4

Recommended Improvements

The curve north of Bearwallow Gap has a curve warning sign and a 35 mph advisory speed plate for the northbound traffic. It was determined that the maximum safe speed for this curve is 30 mph through the use of a ballbank indicator. Sight distance at this location is limited by the vertical rock cut slope on the inside of the curve. The typical accident involves a northbound vehicle leaving the road in the curve. A steep fill slope on the outside of the curve compounds the severity of these run-off-the-road accidents.

The recommended improvements presented below address the safety problems at this site:

List of Improvements	Estimated Cost
● Remove the existing curve warning sign and the 35 mph advisory speed plate.	$ 100.00
● Install a turn warning sign (W1-1, 30"x30") and a 30 mph advisory speed plate (W13-1, 18"x18") on both approaches to this curve. Locate the signs as shown in Figure 6B.	600.00
● Install 14 white bi-directional flexible delineators along the outside of the curve as shown in Figure 6B. Solid white, flexible delineators similar to those manufactured by Carsonite are recommended because of their high visibility during daylight hours.	700.00
● Install 750 feet of wooden guiderail (steel-backed) along the outside of the curve as shown in Figure 6B.	24,000.00
Total Improvement Costs:	**$25,400.00**
Benefit/Cost Ratio:	**1.02**

- NPS should monitor the accident history at this location for a 3-year period to determine the effectiveness of the improvements. If a reduction in accidents is not achieved, NPS should consider the use of directional arrows or chevrons on the outside of the curve.

Hazard Index Calculation Form

Site 6: MP 90.7 - 90.9, Curve north of Bearwallow Gap

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	1.5	acc/yr	33.0	x	0.164	=	5.41
Accident Rate	13.02	acc/MVE	100.0	x	0.225	=	22.50
Accident Severity	11,116	dollars	64.0	x	0.191	=	12.22
Sight Distance Ratio	.64	(wt. avg.)	76.0	x	0.074	=	5.62
Driver Expectancy	4.67	(wt. avg.)	77.8	x	0.149	=	11.59
Information System Deficiencies	5.5	(wt. avg.)	91.7	x	0.115	=	10.55

Hazard Index:	67.89
Cost of Recommended Improvements:	$25,400.00
Cost Factor:	26

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(67.89 x .75) + (26 x .25) = 57.42

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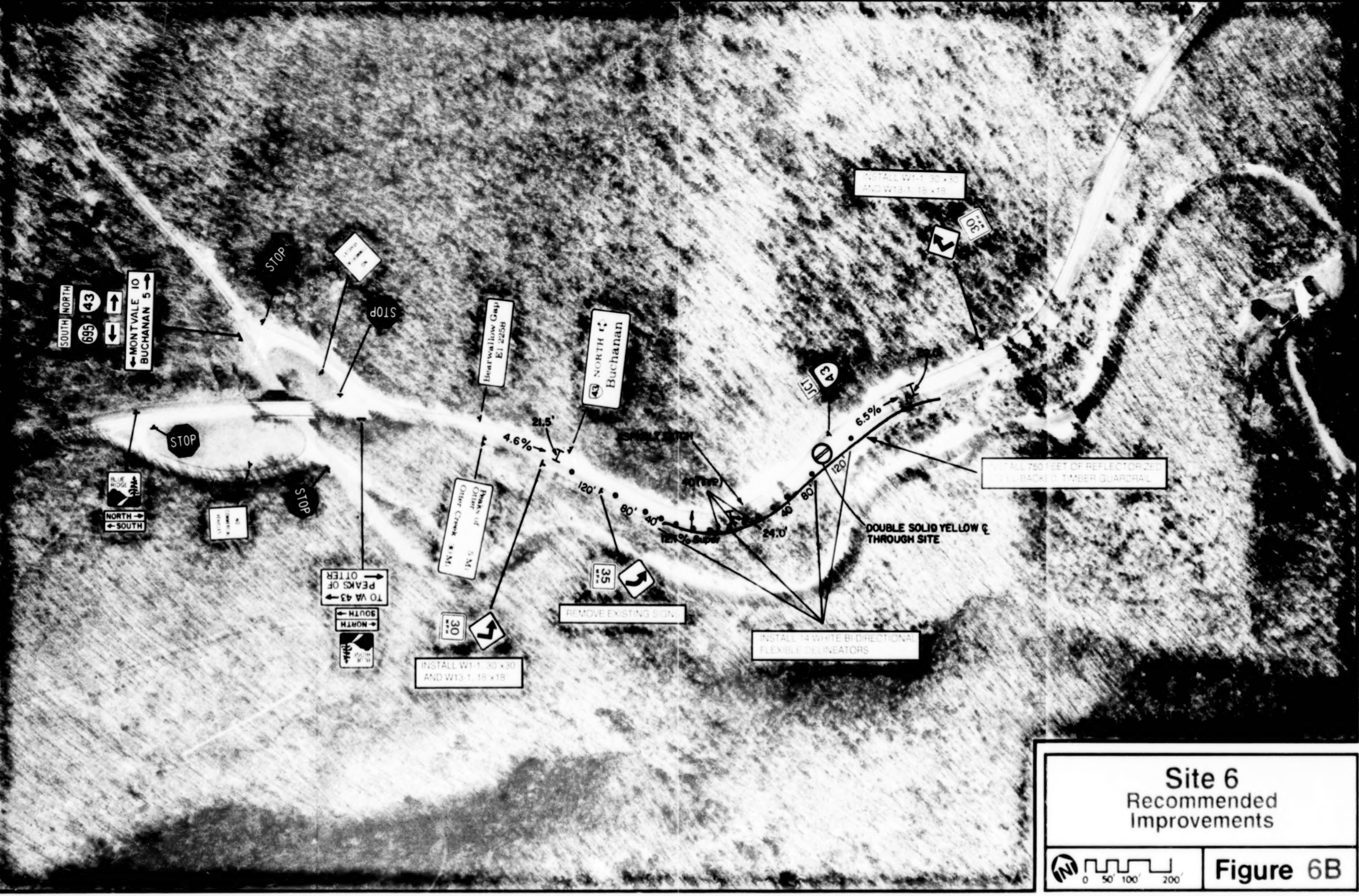
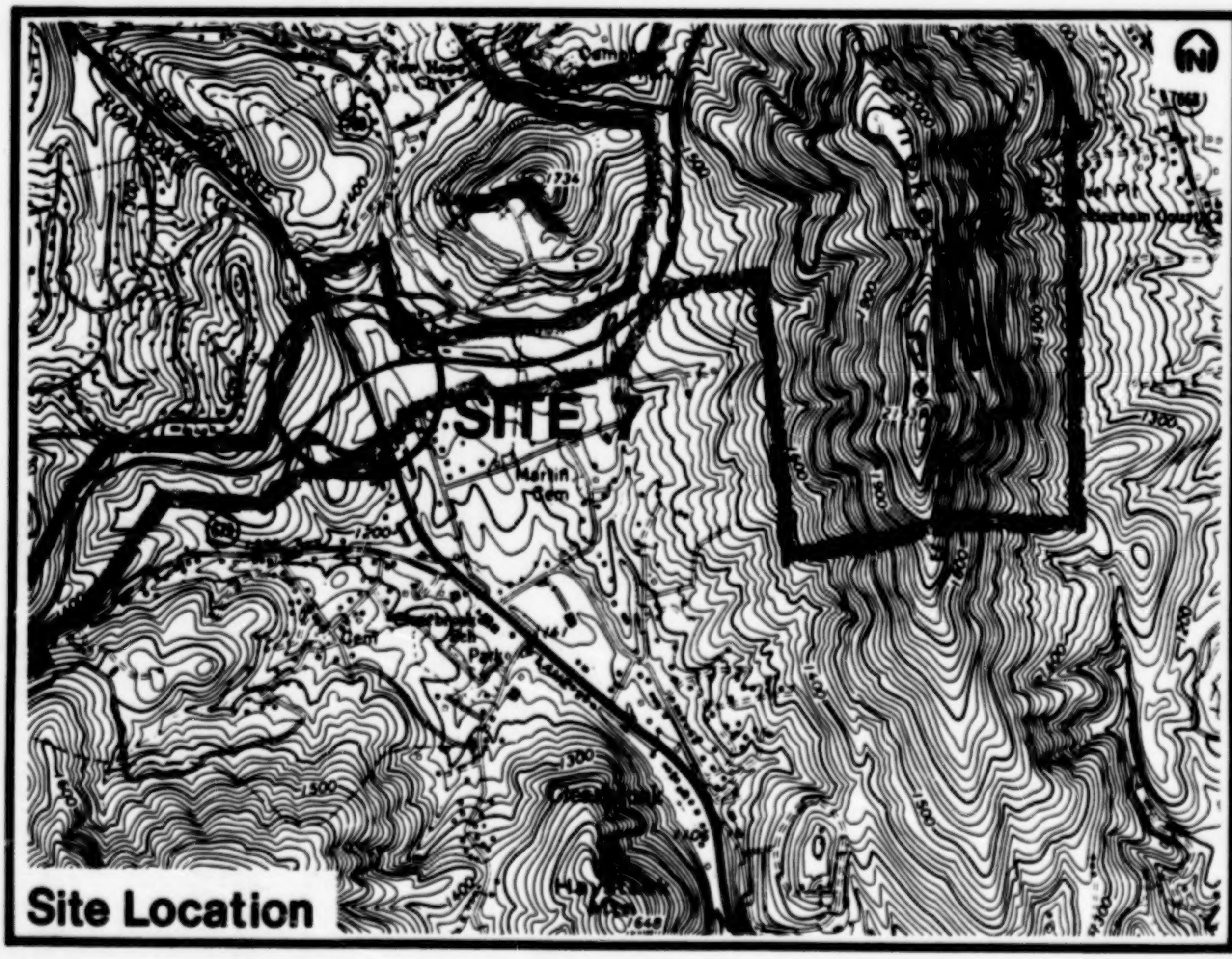


Site 6
Recommended
Improvements

Figure 6B

SITE 7
Existing Conditions

This site consists of a two-quadrant interchange near Parkway Milepost 121.0 on the outskirts of Roanoke, Virginia. The intersections contained in this site are formed by access ramps from the Parkway to U.S. Highway 220. The site also includes an overpass that spans U.S. 220. The general location of this site is shown in the following figure. The access configuration has formed "T" intersections both north and south of the overpass. Measured grades on the Parkway were between 3.6% and 5.4% for the main road and 5% and 12% for the north and south ramps, respectively. Centerline striping prohibits passing through the site and on the access ramps. Access to the Parkway is controlled by stop signs. Yield or stop signs are used at the ramp junctions with U.S. 220. All existing signing and conditions are shown on Figure 7B. The figure also presents the results of turning movement counts conducted at the north and south access ramps to U.S. 220.



Site Location

Blue Ridge Parkway MP 121.0 to 121.2

Accident History

A total of seventeen accidents occurred during the study period at the Parkway interchange with U.S. 220. The location of each accident is presented in Figure 7A. Thirteen accidents involved single vehicles, and the remainder were multi-vehicle collisions. Vehicles impacted the barricade across the Parkway just south of the site on two separate occasions. Two accidents occurred on the south exit ramp, while ten were reported on the north exit ramp. The largest cluster of accidents was located in the curve on the north ramp. All accidents at this ramp location were caused by excessive speed as vehicles traveled through the curve. Only four accidents resulted in injuries. Sixteen accidents happened under clear and dry weather and road conditions. Eleven of the seventeen accidents occurred at night. The following summary identifies important characteristics of all accidents that occurred at Site 7 during the study period.

ACCIDENT DATA

SITE 7: MP 121.0 - 121.2 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
3	2	4	8

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
1	4	2	3	2	3	2

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	1	1	3	3	2		2	1	1	2	1

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	2	1							1			2		1		3	2			1	1	1	2

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
6	11		

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
16	1			

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
16	1		

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
	1	9		1	1	3	1	1	

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

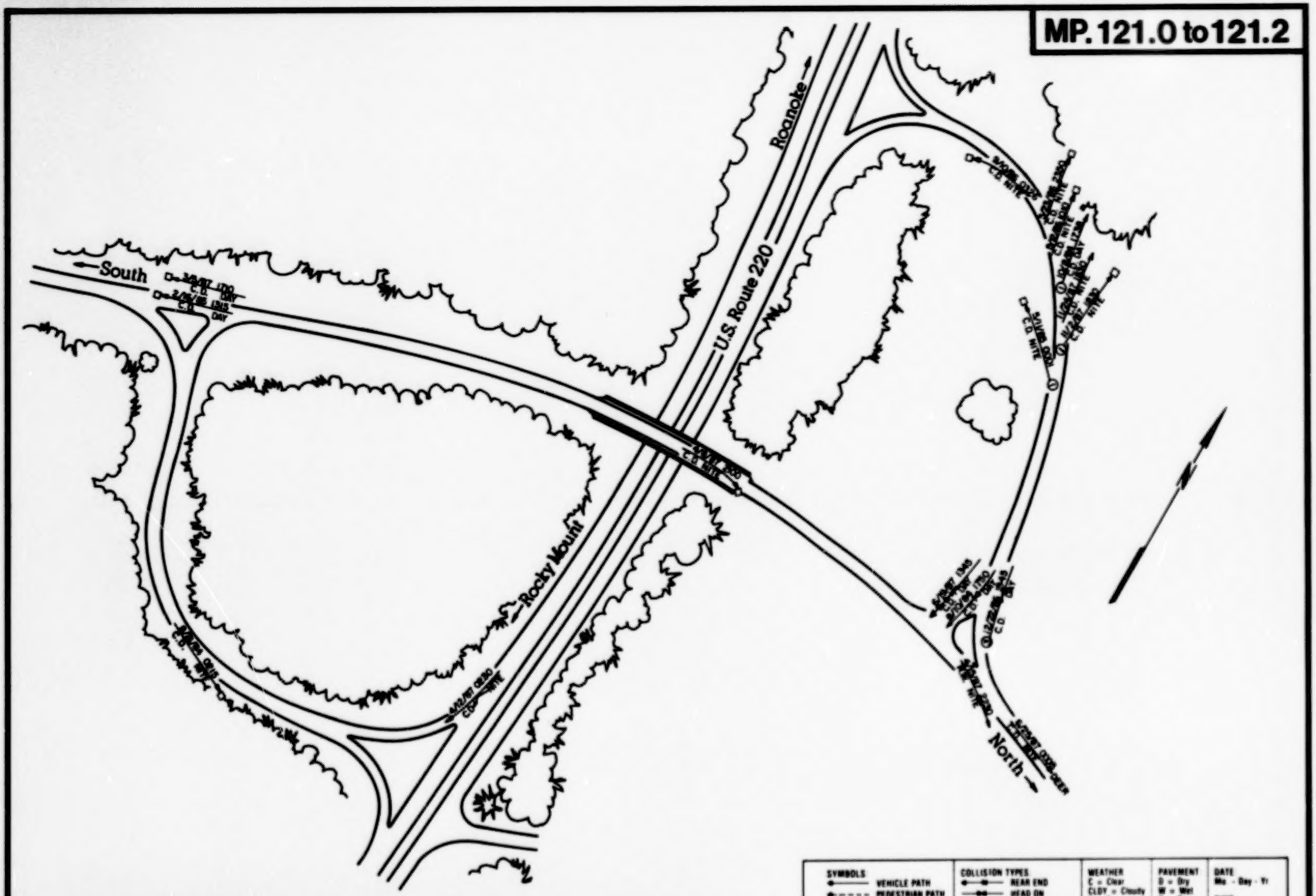
No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
1	3	3	9			1		

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)	1 (1)	1 (1)	1 (3)	1 (1)	4 (6)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.	2	1	3	7	13

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

2



SYMBOLS		COLLISION TYPES		WEATHER	PAVEMENT	DATE
●——	VEHICLE PATH	●—●—	REAR END	C = Clear	D = Dry	Mo - Day - Yr
●- - -	PEDESTRIAN PATH	—●●—	HEAD ON	CLDY = Cloudy	W = Wet	
●◆◆◆	BACKING VEHICLE	◀═	SIDE SWIPE	F = Fog	S = Snow	TIME
▭	PARKED VEHICLE	●◆◆◆—	OUT OF CONTROL	S = Snow	I = Icy	0 - 2400 Hrs
☐	FIXED OBJECT	—●╯	LEFT TURN	SL = Sleet		
●	FATAL ACCIDENT	╭—	ANGLE			
ⓘ	INJURY ACCIDENT (No. Injured)	●—●—	NON-COLLISION			

EXAMPLE
DATE 2/22/84 1600 TIME
WEATHER C.D. DAY LIGHT
PAVEMENT

FIGURE 7A

Blue Ridge Parkway–Site 7 Collision Diagram

0 50' 100' 200'
SCALE

Site Photographs

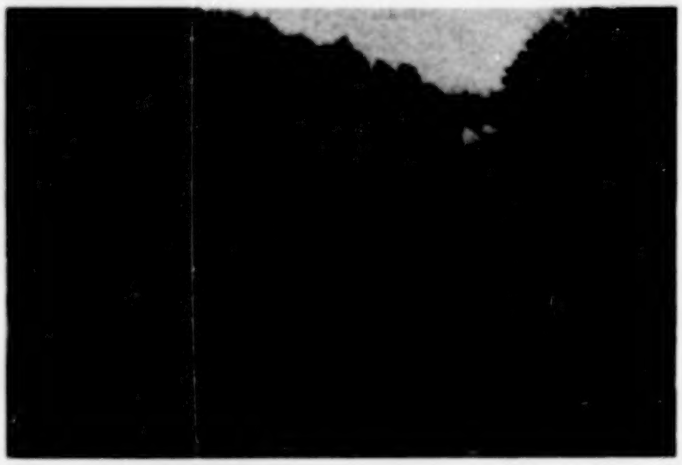
Photograph 1: The hinge posts for the barricade gate located south of the interchange are located within one foot of the edge of the pavement. Note the skid marks on the pavement from a recent collision with the barricade.

Photograph 2: The back slope adjacent to the intersection at the south junction obstructs sight distance for motorists entering the Parkway.

Photograph 3: This curve on the north ramp was the site of many run-off-the-road accidents. The maximum safe speed for the curve was determined to be 20 mph.

Photograph 4: The shoulder is severely rutted at the junction of the north ramp and the Parkway.

Photograph 1



Photograph 2

Photograph 3

Photograph 4

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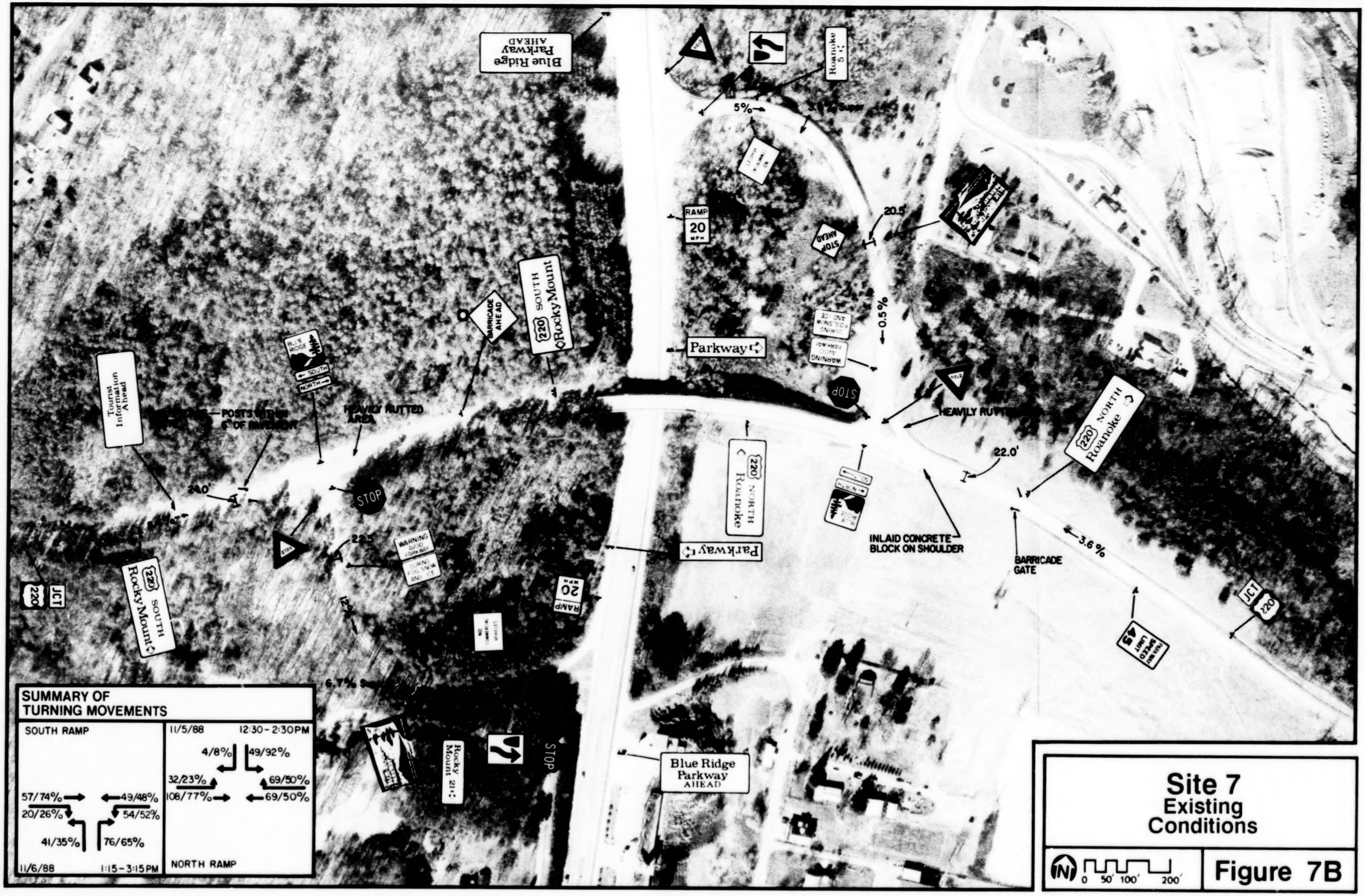


Site 7
Existing Conditions

Figure 7B

Recommended Improvements

Limited sight distance at both Parkway junctions and in the curve on the north exit ramp is the major problem at this site. Accident records also indicate that excessive vehicle speeds was a contributing factor in most of the accidents on the exit ramps. The visibility of the barricade gates located at this interchange could be improved, which would reduce the frequency of barricade collisions.

The improvements recommended below address the problems at the site:

List of Improvements	Estimated Cost
● Install 20 mph advisory exit speed signs (W13-2, 24"x30") on both approaches to this interchange. Install U.S. route markers with directional arrows (M1-4 and M6- 2) on the nose of the medians on the exit ramps as shown in Figure 7C.	$ 1,400.00
● Remove the curb from the raised medians at this site. Removal of the curb from the median at the ramp junction with Route 220 will require State DOT concurrence.	12,000.00
● Install turn warning sign (W1-1, 30"x30") and a 20 mph advisory speed plate (W13-1, 18"x18") in advance of the curve on the north ramp.	300.00
● Install 16 white, flexible delineators along the outside of the curve on the north ramp as shown in Figure 7C.	800.00
● Increase the superelevation of the curve on the north ramp to a maximum of 8%.	6,000.00
● Repair the shoulder rutting on the inside of the curve at the north Parkway junction.	2,000.00
● Flatten the back slope that blocks sight distance on the northeast corner of the Parkway's junction with the south exit ramp.	8,000.00
● Remove trees and brush on the inside of the ramp curves in an effort to improve sight distance.	4,000.00
● Relocate the barricade hinge posts to at least 3 feet from the edge of the pavement. Modify the barricades to accommodate the wider span. Install standard red and white hatched barricade panels on the face of the barricades.	4,000.00
● Replace the existing 30"x30" "Barricade Ahead" sign with a larger 48"x48" sign.	400.00
● Install 4" white shoulder stripes on both exit ramps.	1,500.00
● Install a "Road Closed 1,000 Feet" sign (W20-3, 48"x48") 1,000 feet in advance of both barricades.	800.00

Install a "Barricade Ahead" sign (48"x48") with an amber flashing light 500 feet south of the barricade located at the north end of this site.	1,000.00
Install "Stop Ahead" signs (W3-1A, 30"x30") 300 feet in advance of both stop signs of the south ramp.	600.00

List of Improvements	**Estimated Cost**
Replace the existing yield signs with standard 36" yield signs. Reposition the yield signs to the right side of the exit ramps as shown in Figure 7C.	900.00
Total Improvement Costs:	**$45,100.00**
Benefit/Cost Ratio:	**0.91**

- NPS should monitor the accident history at the site for a 3-year period to determine if the delineators in the north ramp produce a reduction in accidents. If not, NPS should consider the use of chevron warning signs in the curve.

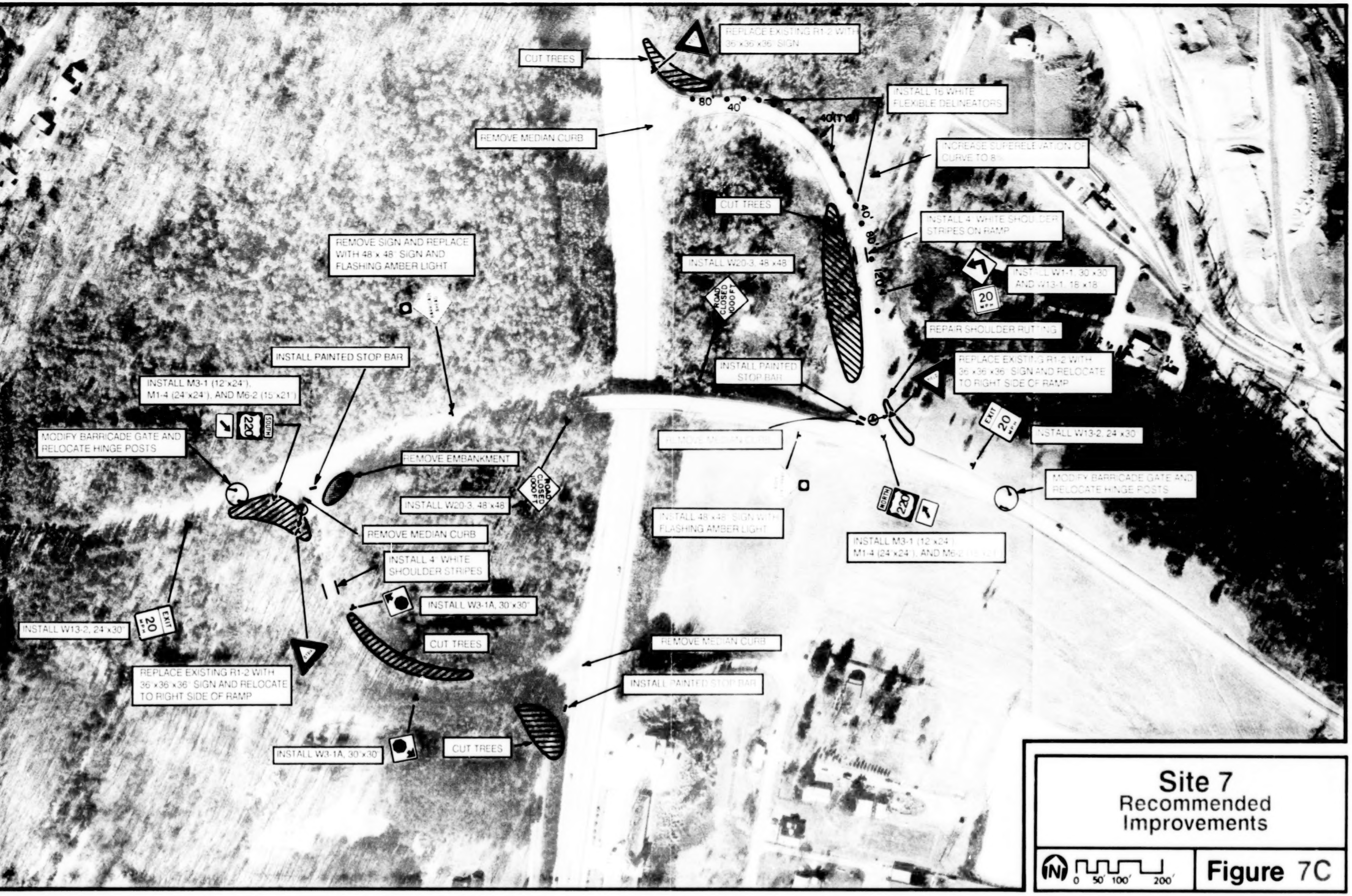
Hazard Index Calculation Form

Site 7: MP 121.0 - 121.2, Junction U.S. 220

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	4.25	acc/yr	51.0	x	0.164	=	8.36
Accident Rate	6.51	acc/MVE	80.0	x	0.225	=	18.00
Accident Severity	11,518	dollars	66.0	x	0.191	=	12.61
Sight Distance Ratio	.53	(wt. avg.)	96.0	x	0.074	=	7.10
Driver Expectancy	4.0	(wt. avg.)	66.7	x	0.149	=	9.94
Information System Deficiencies	3.33	(wt. avg.)	55.5	x	0.115	=	6.38

Hazard Index:	62.39
Cost of Recommended Improvements:	$45,100.00
Cost Factor:	78

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(62.39 x .75) + (78 x .25) = 66.29

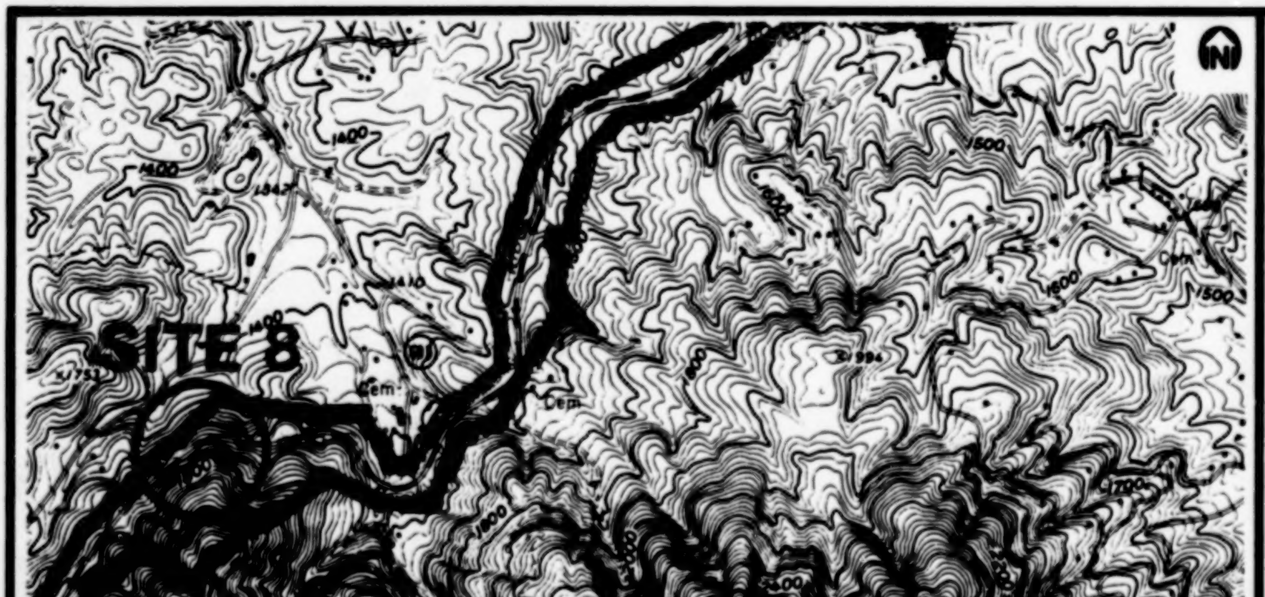

CUT TREES
REPLACE EXISTING R1-2 WITH 36"x36"x36" SIGN
80'
40'
40'(TYP)
INSTALL 16 WHITE FLEXIBLE DELINEATORS
REMOVE MEDIAN CURB
INCREASE SUPERELEVATION OF CURVE TO 8%
CUT TREES
40'
80'
120'
INSTALL 4" WHITE SHOULDER STRIPES ON RAMP
INSTALL W1-1, 30"x30" AND W13-1, 18"x18"
20 MPH
REMOVE SIGN AND REPLACE WITH 48"x 48" SIGN AND FLASHING AMBER LIGHT
INSTALL W20-3, 48"x48"
ROAD CLOSED 1000 FT
REPAIR SHOULDER RUTTING
INSTALL PAINTED STOP BAR
INSTALL PAINTED STOP BAR
REPLACE EXISTING R1-2 WITH 36"x36"x36" SIGN AND RELOCATE TO RIGHT SIDE OF RAMP
INSTALL M3-1 (12"x24"), M1-4 (24"x24"), AND M6-2 (15"x21")
SOUTH
220
EXIT 20 MPH
INSTALL W13-2, 24"x30"
MODIFY BARRICADE GATE AND RELOCATE HINGE POSTS
REMOVE EMBANKMENT
REMOVE MEDIAN CURB
INSTALL W20-3, 48"x48"
ROAD CLOSED 1000 FT
MODIFY BARRICADE GATE AND RELOCATE HINGE POSTS
REMOVE MEDIAN CURB
INSTALL 48"x48" SIGN WITH FLASHING AMBER LIGHT
NORTH
220
INSTALL M3-1 (12"x24"), M1-4 (24"x24"), AND M6-2 (15"x21")
INSTALL 4" WHITE SHOULDER STRIPES
INSTALL W3-1A, 30"x30"
INSTALL W13-2, 24"x30"
EXIT 20 MPH
CUT TREES
REPLACE EXISTING R1-2 WITH 36"x36"x36" SIGN AND RELOCATE TO RIGHT SIDE OF RAMP
REMOVE MEDIAN CURB
INSTALL PAINTED STOP BAR
INSTALL W3-1A, 30"x30"
CUT TREES
N
0
50'
100'
200'

Site 7
Recommended Improvements

Figure 7C

SITE 8
Existing Conditions

This site includes a 0.2 mile segment of the Parkway between Mileposts 128.0 and 128.2. Site 8, shown in the following map, is located approximately 7 miles south of Roanoke and includes a pair of mild, reverse curves. The Parkway's road surface varies from 20.0 feet to 23.0 feet wide within the site and has grades that range from 6 to 8%. The roadway surface is in generally good condition at this site. A wooden guiderail with concrete posts has been installed in the southernmost curve at this location. The centerline prohibits passing through the curves but allows passing for southbound motorists near Milepost 128.2. No traffic control signing exists within the site; however, a curve warning sign is located south of the site and provides information for northbound visitors. Asphalt-lined channels and an asphalt curb have been installed to transport storm water from the Parkway. The traffic volume on this portion of the Parkway is estimated to be approximately 560 vehicles per day.



Site Location

Blue Ridge Parkway
MP 128.0 to 128.2

Accident History

All six accidents at this site during the study period involved single-vehicles travelling northbound through the curves. Excessive speed caused drivers to lose control in the curves in all accidents at Site 8. Vehicles struck the wooden guiderail located on the outside of the curve in five accidents at this site. Vehicles broke through the guiderail in two accidents and partially vaulted the guiderail causing roll-overs in two others. Injuries occurred in four accidents. Five accidents took place when conditions were clear and dry. Only one occurred during the day. The locations of all accidents at this site are presented in Figure 8A. Accident characteristics for this site are summarized below.

ACCIDENT DATA

SITE 8: MP 128.0 - 128.2 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
2	2	1	1

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
1	1	1			1	2

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		3		1		1		1			

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
			1		1									1				1			2		

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
1	4		1

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
5		1		

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
5		1	

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
		6							

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
			6					

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)		2 (2)	1 (2)	1 (2)	4 (6)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.	2				2

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

0

MP. 128.0 to 128.2

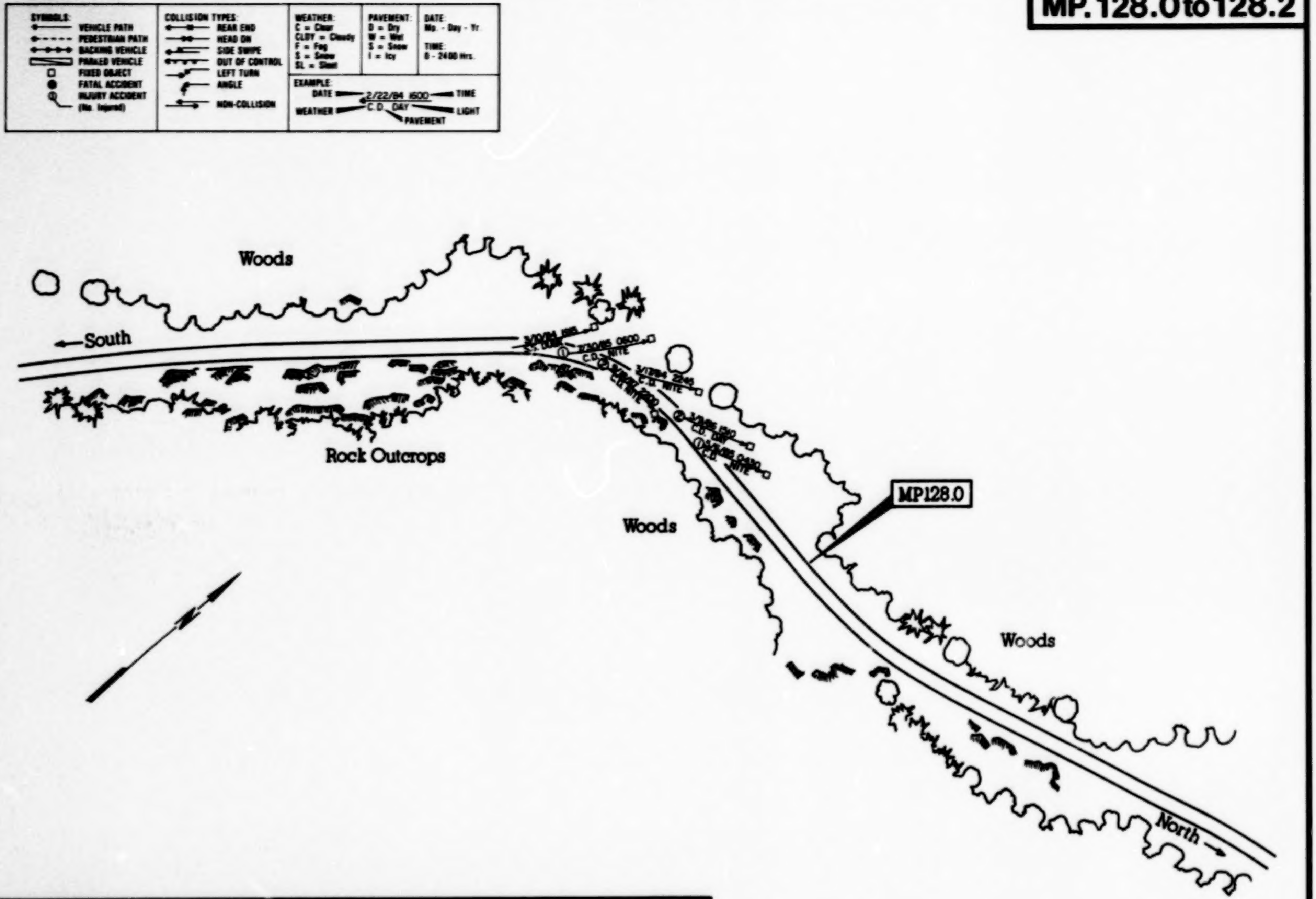


FIGURE 8A

Blue Ridge Parkway–Site 8 Collision Diagram

0 50' 100' 200'
SCALE

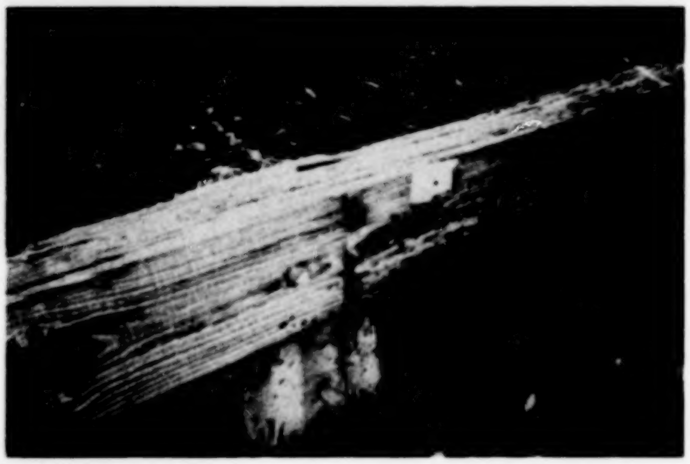
Site Photographs

Photograph 1: Amber reflectors have been mounted on the face of the existing guiderail to delineate the curve.

Photograph 2: Several accidents at the site have occurred as vehicles struck the guide rail and continued down the steep fill slope.

Photograph 3: The cut slope adjacent to the Parkway obstructs sight distances through the curve.

Photograph 4: The guiderail at the site begins at MP 128 and extends southward through the curve. Portions of the guiderail are less than one foot above the level of the road surface.



Photograph 1

Photograph 2

Photograph 3

Photograph 4

Recommended Improvements

The evidence of past run-off-the-road accidents indicates the existing guiderail does not effectively redirect errant vehicles. Sections of the existing guiderail are only 8" to 10" above the level of the road surface. The curve signing in Site 8 is also ineffective because the existing warning sign is located over 1,200 feet south of the curve. This placement is more than twice the standard setback distance for such signing.

The following improvements are recommended to correct the deficiencies at this site:

List of Improvements	Estimated Cost
● Remove the existing curve warning sign located south of the site.	$ 100.00
● Install curve warning signs (W1-2, 30"x30") on both approaches to this site. Locate the signs as show in Figure 8B. The maximum safe speed for this curve was determined to be 35 mph; therefore, 35 mph advisory speed plates (W13-1, 18"x18") should accompany the curve warning signs.	600.00
● Repair the shoulder area on the outside of the curve where rutting has occurred.	2,000.00
● Remove the existing guiderail and install a new timber guardrail equipped with steel-backed bracing. The new guide rail should be reflectorized using 3" white reflectors attached to the face of the guardrail. The reflectors should be spaced 50 feet.	38,500.00
Total Improvement Costs:	**$41,200.00**
Benefit/Cost Ratio:	**1.05**

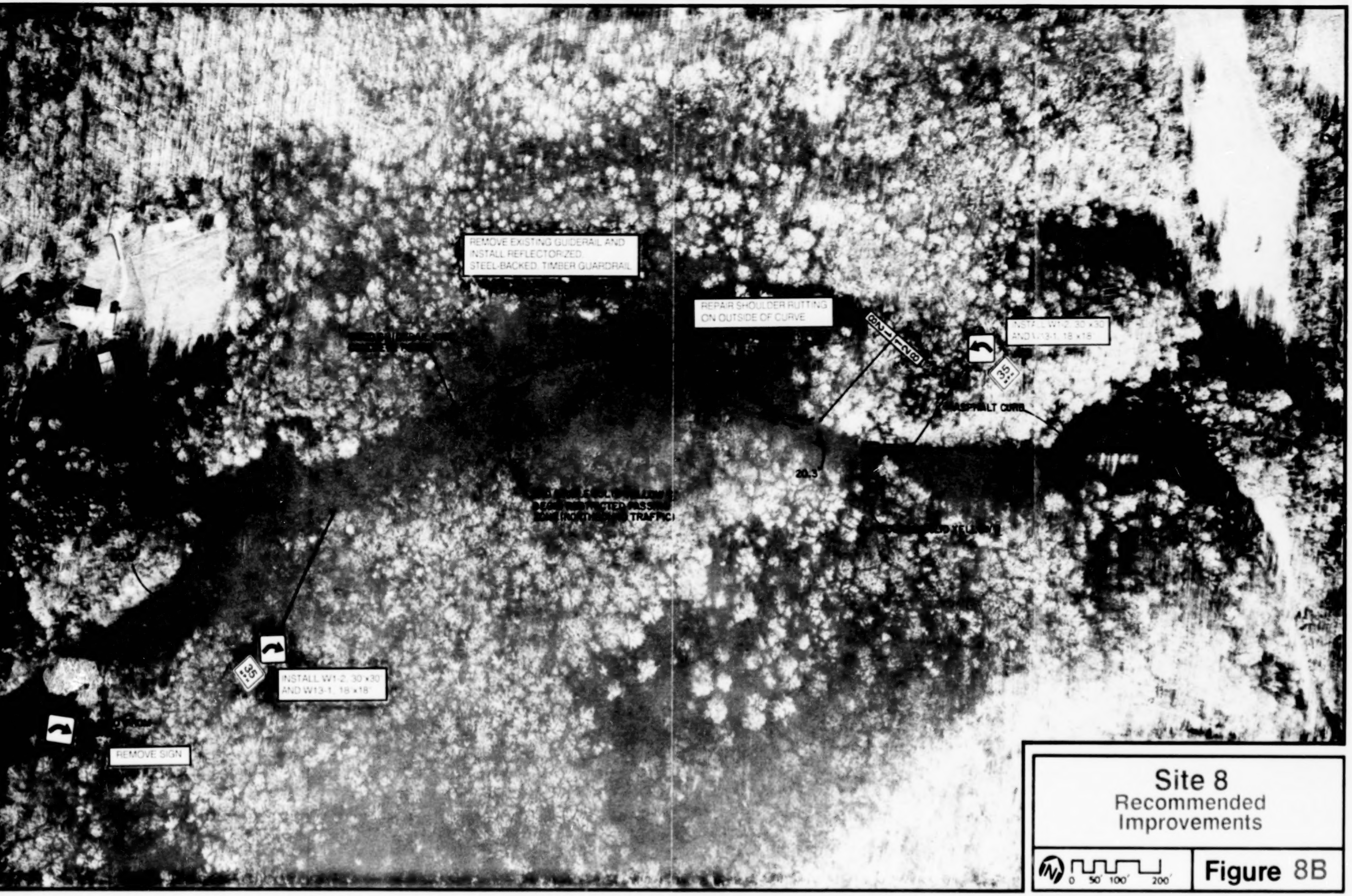
Hazard Index Calculation Form

Site 8: MP 128.0 - 128.2

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	1.5	acc/yr	33.0	x	0.164	=	5.41
Accident Rate	8.80	acc/MVE	94.0	x	0.225	=	21.15
Accident Severity	12,400	dollars	69.0	x	0.191	=	13.18
Sight Distance Ratio	.80	(wt. avg.)	85.0	x	0.074	=	6.29
Driver Expectancy	2.5	(wt. avg.)	41.7	x	0.149	=	6.21
Information System Deficiencies	3.33	(wt. avg.)	55.5	x	0.115	=	6.38

Hazard Index:	58.62
Cost of Recommended Improvements:	$41,200.00
Cost Factor:	20

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(58.62 x .75) + (20 x .25) = 48.97

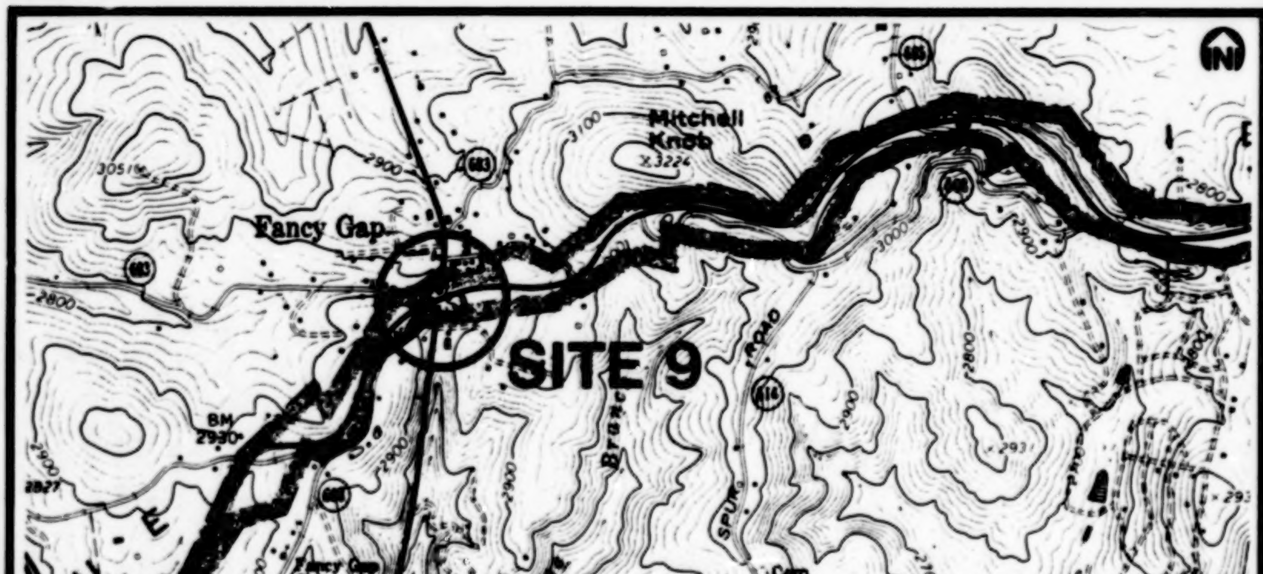

REMOVE EXISTING GUIDERAIL AND INSTALL REFLECTORIZED STEEL-BACKED TIMBER GUARDRAIL
REPAIR SHOULDER RUTTING ON OUTSIDE OF CURVE
INSTALL W1-2, 30"x30" AND W13-1, 18"x18"
ASPHALT CURB
20.3
TRAFFIC)
35
INSTALL W1-2, 30"x30" AND W13-1, 18"x18"
REMOVE SIGN
0 50' 100' 200'

Site 8
Recommended
Improvements

Figure 8B

SITE 9
Existing Conditions

Site 9 includes a two-quadrant interchange located near Parkway Milepost 199.5 as shown in the map at the bottom of the page. The site consists of the access ramps to U.S. Highway 52, an overpass, and two intersections on the Blue Ridge Parkway. U.S. 52 provides access to Fancy Gap, Virginia and Mount Airy, North Carolina. Interstate 77 may also be accessed from the Parkway via U.S. 52. Grades on the main Parkway are approximately 7% while those on the access ramps are generally 8 to 9%. The Parkway and its access ramps are typically 20.5 feet wide. A double solid yellow centerline has been installed on the Parkway and access ramps to prohibit passing. Access onto the Parkway and U.S. 52 is controlled by stop signs. All existing conditions and signing are presented in Figure 9B. A summary of turning movement counts conducted at both the north and south ramps is also presented in Figure 9B.



Site Location

Blue Ridge Parkway
MP 199.3 to 199.5

Accident History

A total of ten accidents occurred at this location during the four-year study period. Figure 9A shows the locations of each accident reported at Site 9. Six of the ten accidents took place when the road surface was wet or icy. Four of the accidents involved collisions between two vehicles (one rear-end, one angle, and two sideswipes) and occurred on or near the north exit ramp. All four of the single-vehicle accidents resulted from a loss of control and collisions with roadside fixed-objects. Four accidents at this site produced five injuries. Six accidents happened during daylight hours, and nine took place in clear weather. A composite summary of pertinent accident data is presented below.

ACCIDENT DATA

SITE 9: MP 199.3 - 199.5 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
3	1	3	3

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
3	2			2	1	2

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
3			1	1					2	1	2

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
		1			1		1	1		1	3					1	1						

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
6	3	1	

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
4	1		5	

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
9			1

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
1	1	6			2				

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
7		2		1				

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)	1 (1)	1 (1)		2 (3)	4 (5)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.	2		3	1	6

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

0

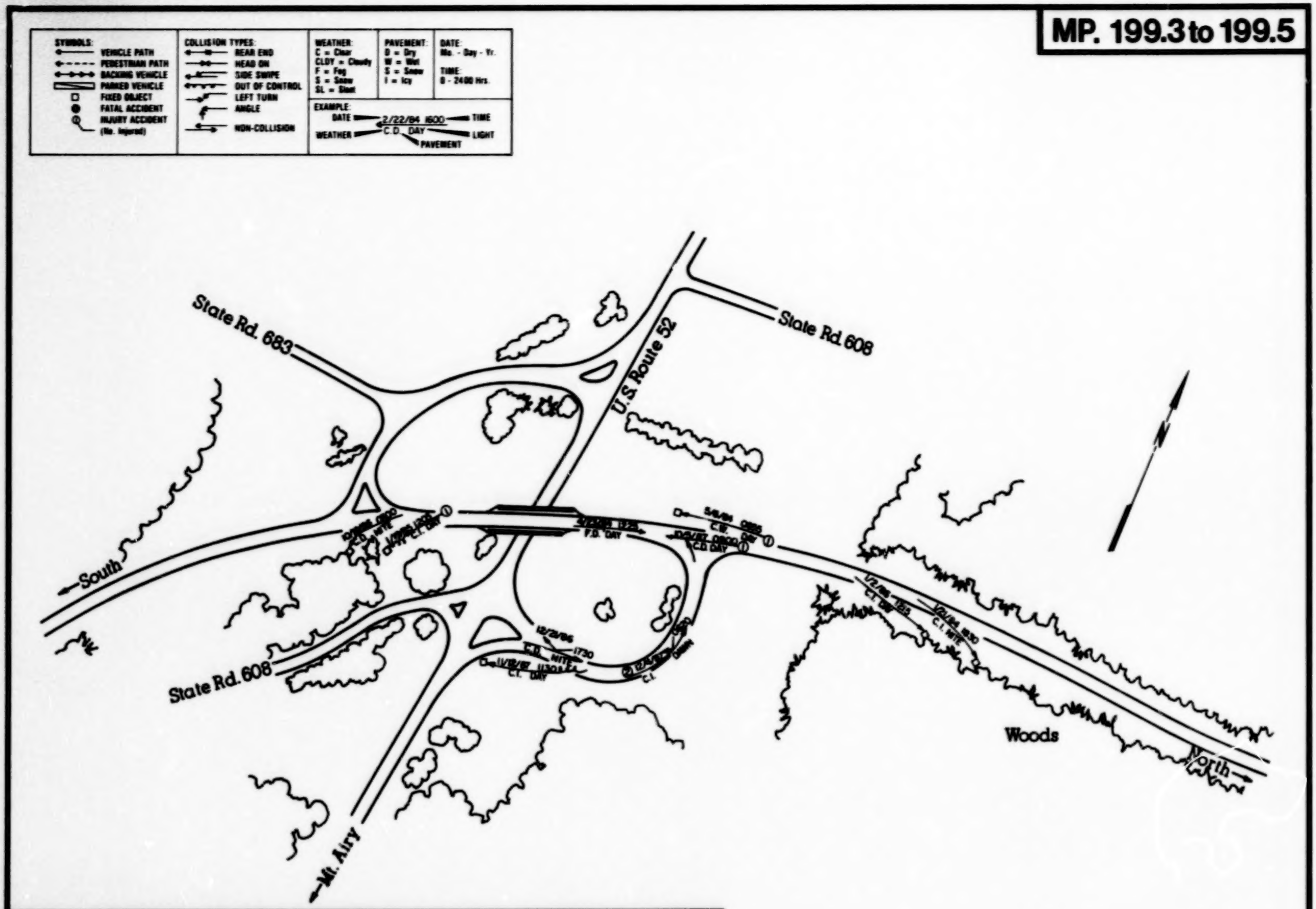


FIGURE 9A

Blue Ridge Parkway-Site 9 Collision Diagram

0 50' 100' 200'
SCALE

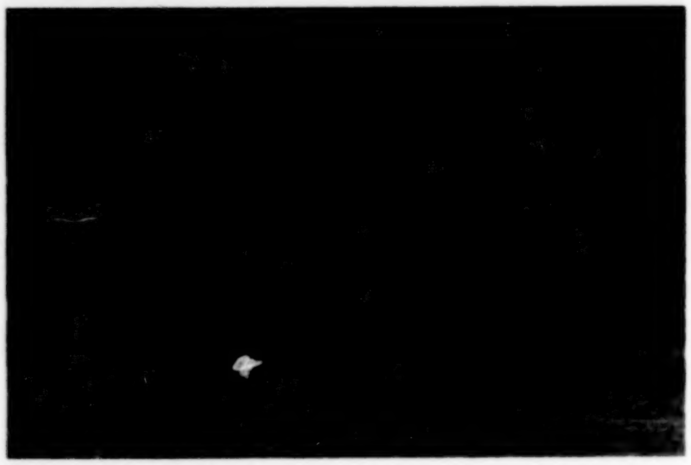
Site Photographs

Photograph 1: The trees adjacent to the north ramp junction obstruct the motorists' view of approaching traffic during the summer months.

Photograph 2: This photograph shows the raised median that exists at this site. Additionally, the photo indicates that the stop sign is located some 50 feet from the intersection.

Photograph 3: The raised median at the junction of the south ramp and the Parkway shows evidence of numerous vehicle collisions.

Photograph 4: The sight distance on the Parkway between the ramps is unobstructed. The rockwall on the overpass is located about six feet from the edge of the road.



Photograph 1

Photograph 2

Photograph 3

Photograph 4

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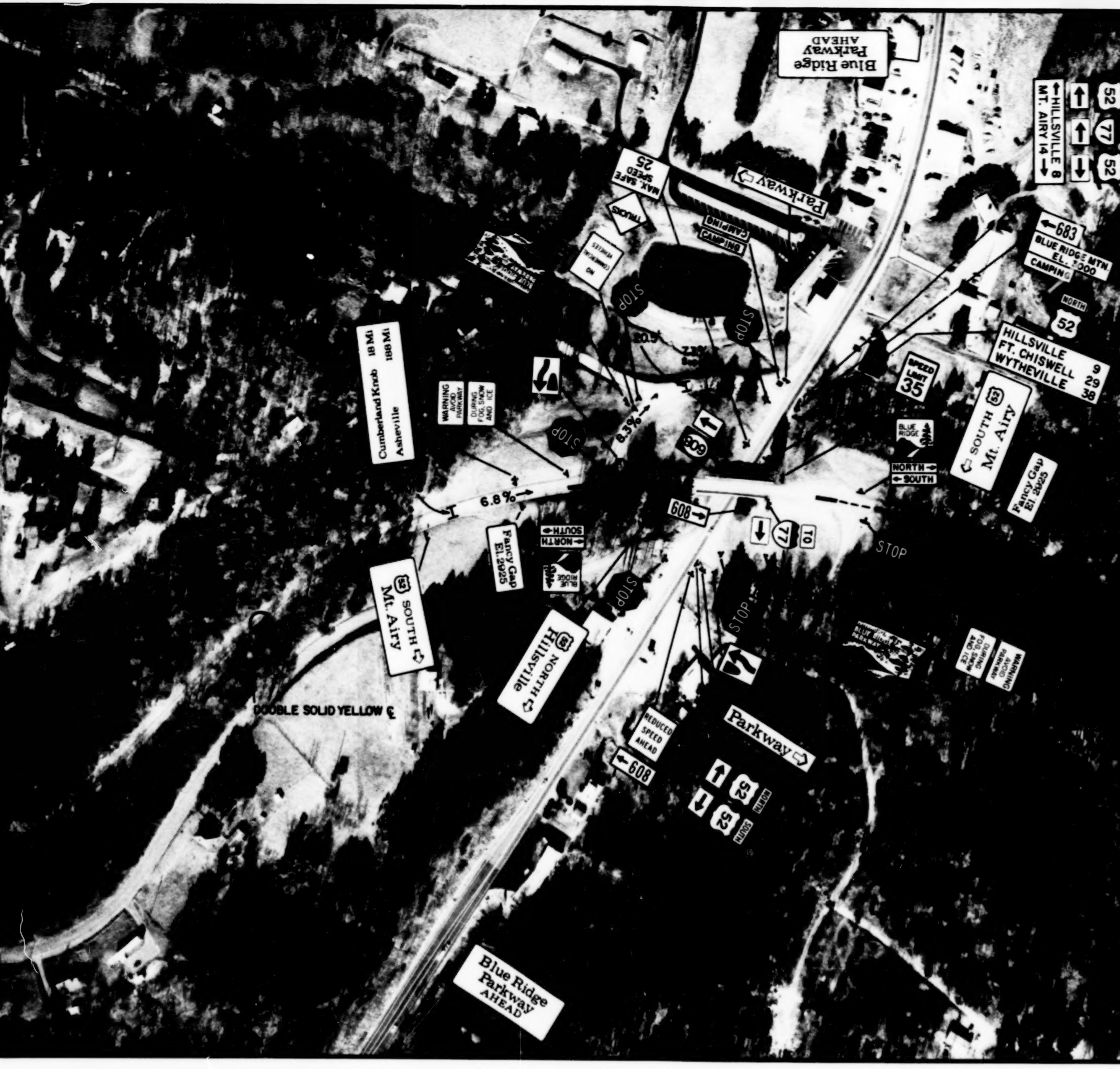
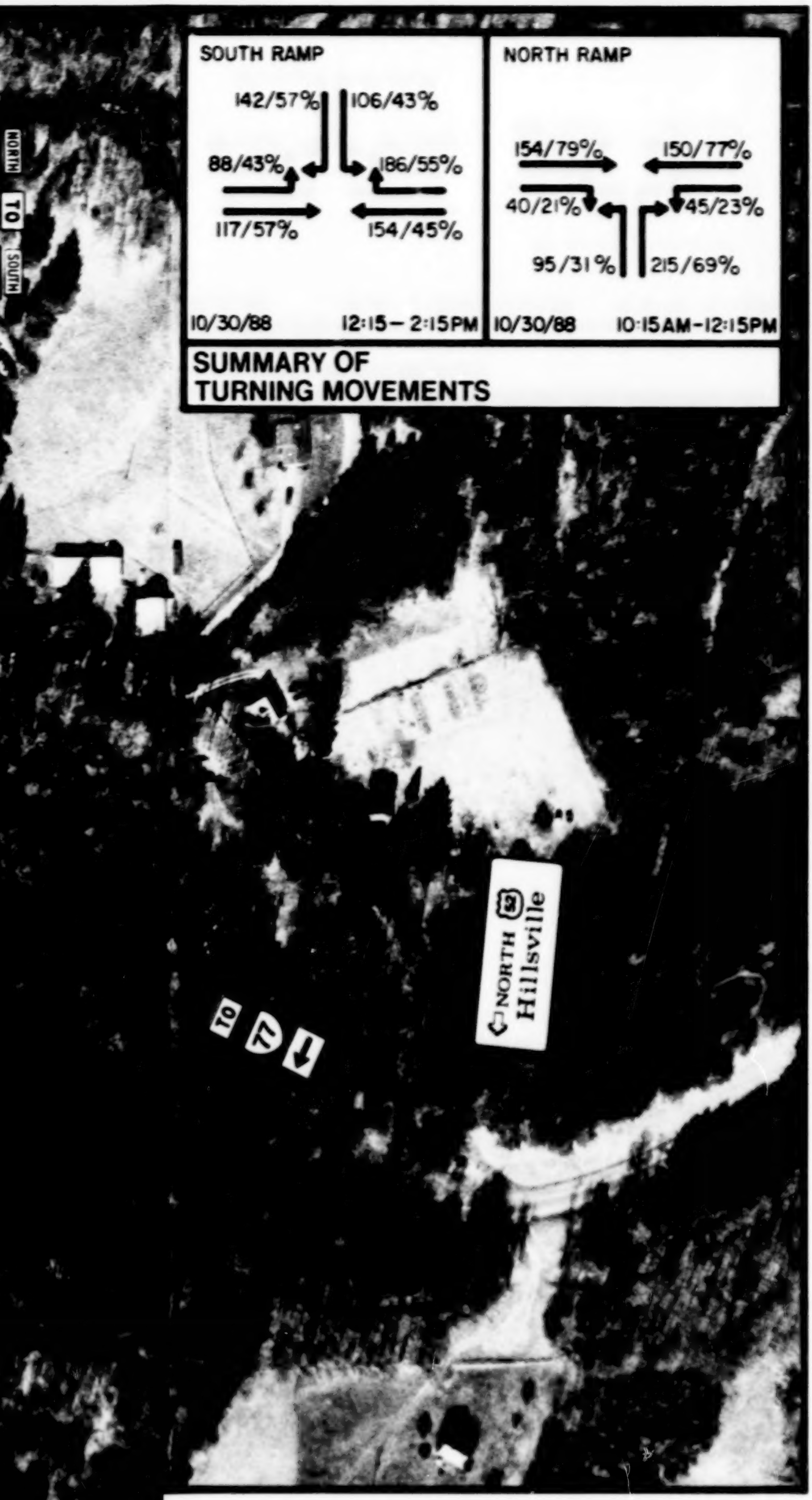
PAGE


Blue Ridge Parkway AHEAD
52 77 52
HILLSVILLE 8
MT. AIRY 14
Parkway
MAX. SAFE SPEED 25
TRUCKS
NO COMMERCIAL VEHICLES
CAMPING
CAMPING
STOP
STOP
683
BLUE RIDGE MTN. EL. 3000
CAMPING
NORTH 52
HILLSVILLE 9
FT. CHISWELL 29
WYTHEVILLE 38
SPEED LIMIT 35
Cumberland Knob 18 Mi
Asheville 188 Mi
WARNING AVOID PARKWAY
DURING FOG, SNOW AND ICE
8.3%
STOP
608
SOUTH 52 Mt. Airy
BLUE RIDGE
NORTH
SOUTH
Fancy Gap El. 2925
6.8%
Fancy Gap El. 2925
SOUTH
NORTH
BLUE RIDGE
608
TO 77
STOP
STOP
STOP
52 SOUTH Mt. Airy
52 NORTH Hillsville
BLUE RIDGE PARKWAY
DURING FOG, SNOW AND ICE
WARNING AVOID PARKWAY
DOUBLE SOLID YELLOW ℄
REDUCED SPEED AHEAD
Parkway
608
NORTH 52
SOUTH 52
Blue Ridge Parkway AHEAD



Site 9
Existing Conditions

0 50' 100' 200'

Figure 9B

Recommended Improvements

Site investigations at the U.S. 52 interchange identified extensive shoulder wear at both Parkway junctions and numerous vehicle strike marks on the raised median island at the south ramp junction. Trees and shrubs limit the sight distance at several locations within this site. The Parkway signing of this interchange is appropriate; however, the proliferation of state and county signs on U.S. 52 is undesirable and most likely ineffective.

The recommendations presented below address the deficiencies at this site:

List of Improvements	Estimated Cost
● Remove the lower tree limbs that block the motorist's view of the stop sign at the south ramp junction with U.S. 52.	$ 300.00
● Relocate both stop signs closer to the intersections at both north ramp junctions.	600.00
● Trim back trees and shrubs that limit the view of the signing and the intersection geometrics as shown in Figure 9C.	3,000.00
● Remove the raised median located in the intersection of the south ramp and the Parkway.	10,000.00
● Install 4" white shoulder stripes on both ramps.	1,500.00
● Install painted stop bars adjacent to each stop sign at this site.	800.00
● Repair all shoulder rutting at this interchange using concrete paving blocks placed flush along the edge of the pavement.	3,000.00
● Request that the State and County Road Departments review their signing at this location in an effort to minimize the sign clutter and increase the effectiveness of the Parkway signing. (No cost provided.)	
● The use of a course grade asphalt or a high friction chip and seal should be considered for the Parkway in this area to minimize the number of icy road accidents. (No cost provided.)	
Total Improvement Costs:	**$19,200.00**
Benefit/Cost Ratio:	**1.43**

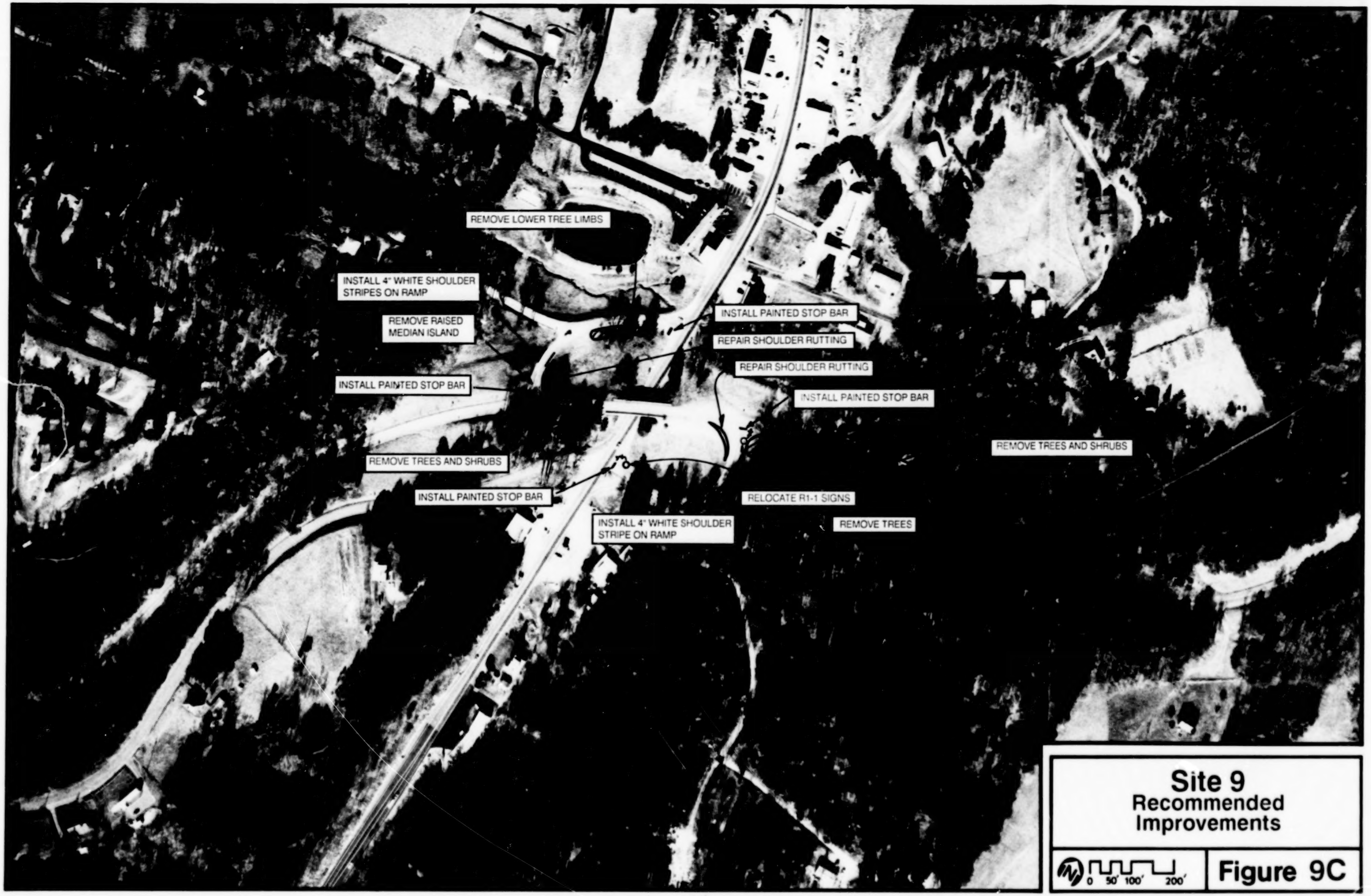
Hazard Index Calculation Form

Site 9: MP 199.3 - 199.5

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	2.5	acc/yr	40.0	x	0.164	=	6.56
Accident Rate	4.05	acc/MVE	56.0	x	0.225	=	12.60
Accident Severity	11,290	dollars	65.0	x	0.191	=	12.42
Sight Distance Ratio	.66	(wt. avg.)	74.0	x	0.074	=	5.48
Driver Expectancy	2.0	(wt. avg.)	33.3	x	0.149	=	4.96
Information System Deficiencies	2.83	(wt. avg.)	47.2	x	0.115	=	5.43

Hazard Index:	47.45
Cost of Recommended Improvements:	$19,200.00
Cost Factor:	90

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(47.45 x .75) + (90 x .25) = 58.09



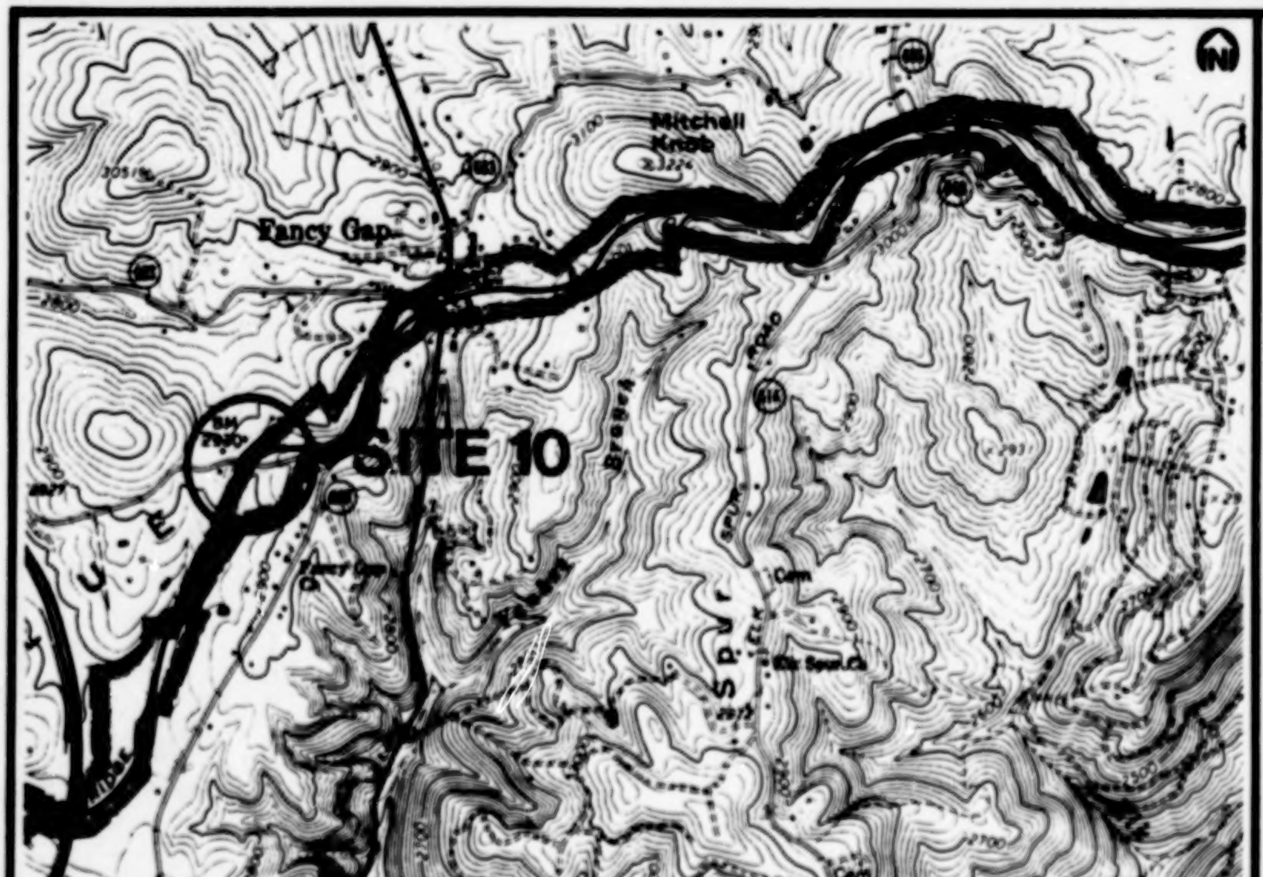
Site 9
Recommended Improvements

Figure 9C

SITE 10

Existing Conditions

This site consists of a four-way, at-grade crossing formed by the intersection of the Blue Ridge Parkway and Virginia Secondary Highway 778. The site, shown at the bottom of the page, is located approximately one mile south of Site 9 at Mileposts 199.8 to 200.0. The Parkway's road surface ranges from 20.5 to 21.5 feet in width through the site and has grades between 5.4 and 6.8%. The west approach is 18.0 feet wide and has a 3.3% grade whereas the east approach is 17.0 feet wide and has a 9.2% grade in the vicinity of the intersection. The roadway through this site has a posted speed limit of 45 miles per hour. The Parkway is striped to prohibit passing within the site. Stop signs are used to regulate traffic on the east and west approaches to the intersection. The condition of the roadway surface is generally good. The existing conditions and the results of a turning movement count at this crossing are presented in Figure 10B.



Site Location

Blue Ridge Parkway
MP 199.8 to 200.0

Accident History

Six accidents occurred within the limits of this site during the study period. Four accidents happened in the immediate vicinity of the intersection while the other two occurred in the curve north of the junction. Locations of the accidents are shown in Figure 10A. One angle collision and three fixed-object collisions occurred at this site. Two of the six accidents resulted in vehicle roll-overs. Four accidents resulted in injuries to four people. Five of the six accidents took place when road and weather conditions were clear and dry. Four accidents occurred at night. A summary of accident characteristics follows this narrative.

ACCIDENT DATA

SITE 10: MP 199.8 - 200.0 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
2		2	2

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
2			1		1	2

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
3		2				1					

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1		1		1						1			1									1	

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
2	4		

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
5			1	

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
6			

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
1		3				2			

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
1	1		3	1				

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)	1 (1)		1 (1)	2 (2)	4 (4)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.	1		1		2

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

0

MP. 199.8 to 200.0

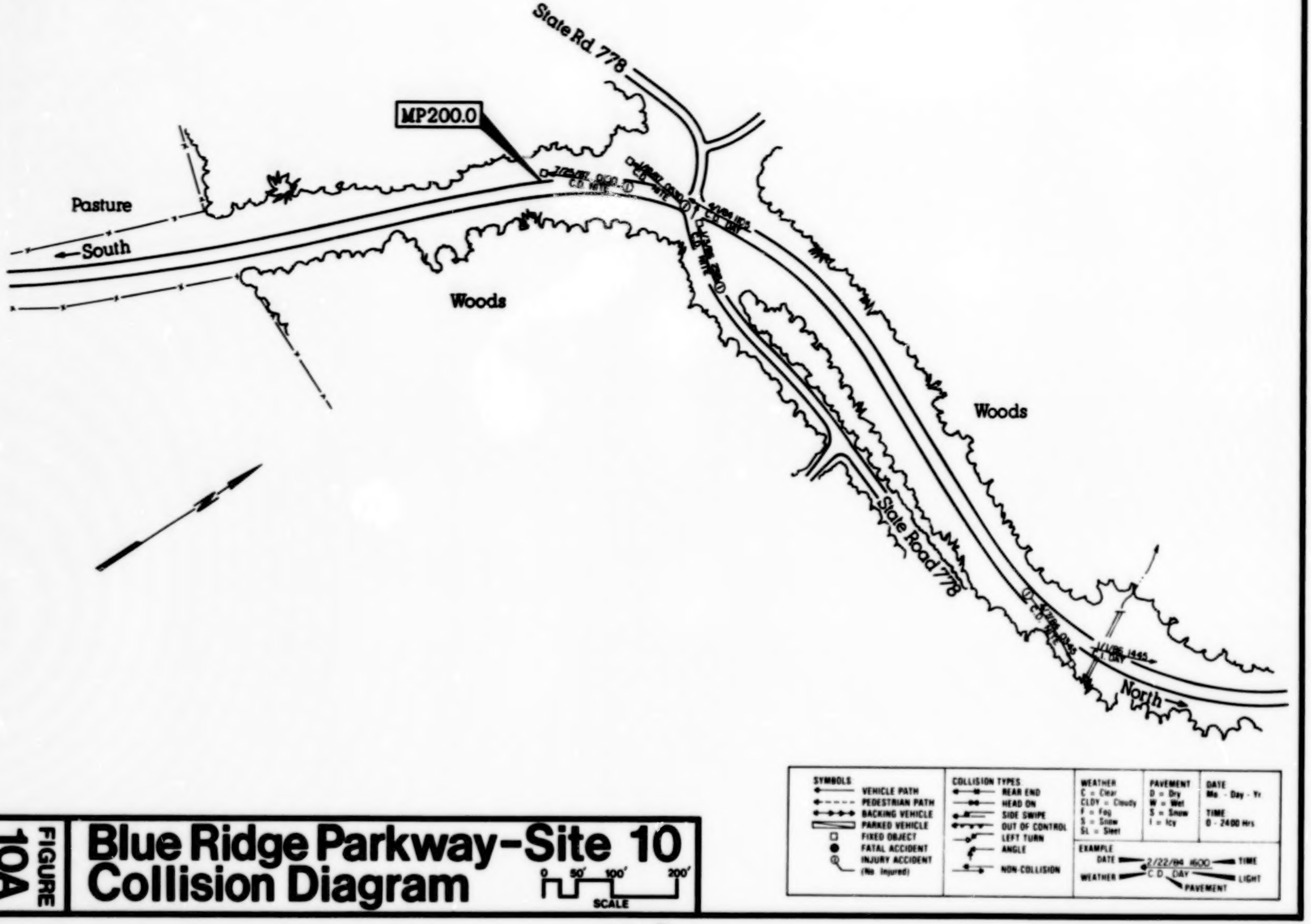


FIGURE 10A

Blue Ridge Parkway-Site 10 Collision Diagram

0 50' 100' 200'
SCALE

Site Photographs

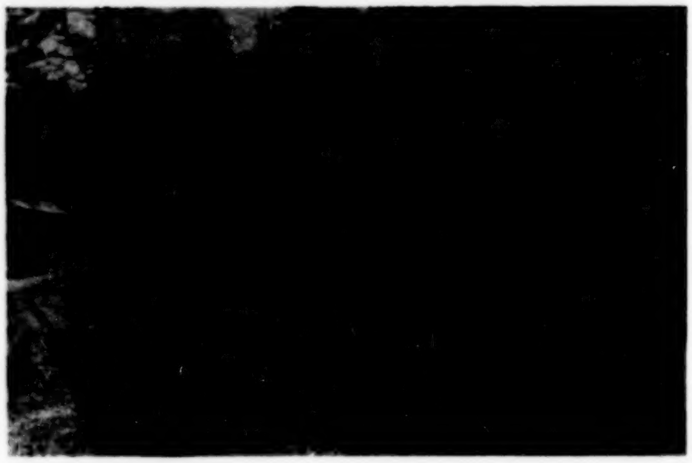
Photograph 1: This photograph shows a view of the intersection from the east approach.

Photograph 2: Trees along the west approach block the motorist's view of the intersection. Note the deteriorated condition of the "Stop Ahead" sign.

Photograph 3: The cut slope located on the northeast corner of the intersection obstructs sight distance.

Photograph 4: Vehicles stopped on the west approach cannot see southbound traffic due to the large cut slope on the opposite side of the road.

Photograph 1



Photograph 2

Photograph 3

Photograph 4

Recommended Improvements

Limited sight distance is the major problem at this intersection. Motorists cannot clearly see the intersection due to trees or the ground contour on all but the south approach. There is a need to better identify the curve and the intersection for approach traffic on the Parkway. The signing on the side road approach should also be upgraded to increase its effectiveness.

The recommendations presented below address the deficiencies at this site:

List of Improvements	Estimated Cost
● Remove trees and lay back the cut slope located on the northeast corner of the intersection.	$ 5,000.00
● Remove the trees along both side approaches that block the view of the intersection.	2,000.00
● Remove the existing "Stop Ahead" sign on the west approach.	100.00
● Install "Stop Ahead" signs (W3-1A, 30"x30") 400 feet from the intersection on both side road approaches.	500.00
● Install 30"x30" stop signs (R1-1) and painted stop bars on both side road approaches.	900.00
● Install "Cross Road Ahead" warning signs (W2-1, 30"x30") on the north and south Parkway approaches to this intersection. Place one sign 750 feet south of the intersection and one 900 feet north of the intersection as shown in Figure 10B.	500.00
● Install a curve warning sign (W1-2, 30"x30") 750 feet north of the curve for the southbound traffic.	250.00
Total Improvement Costs:	**$ 9,250.00**
Benefit/Cost Ratio:	**1.22**

Hazard Index Calculation Form

Site 10: MP 199.8 - 200.0

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	1.5	acc/yr	33.0	x	0.164	=	5.41
Accident Rate	3.97	acc/MVE	55.0	x	0.225	=	12.38
Accident Severity	10,783	dollars	64.0	x	0.191	=	12.22
Sight Distance Ratio	.59	(wt. avg.)	88.0	x	0.074	=	6.51
Driver Expectancy	4.33	(wt. avg.)	72.2	x	0.149	=	10.76
Information System Deficiencies	3.5	(wt. avg.)	58.3	x	0.115	=	6.70

Hazard Index: 53.98
Cost of Recommended Improvements: $9,250.00
Cost Factor: 92

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(53.98 x .75) + (92 x .25) = 63.49

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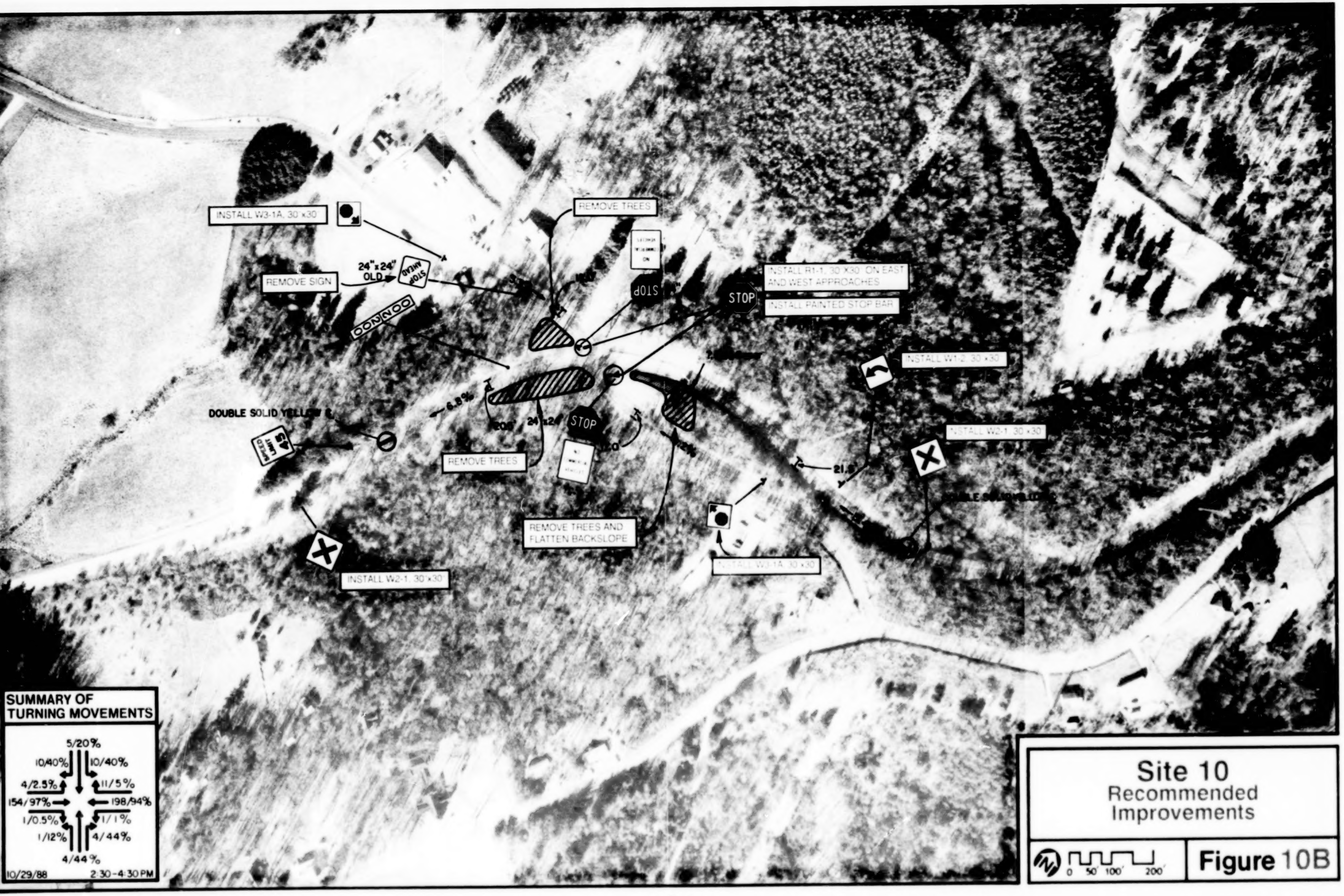
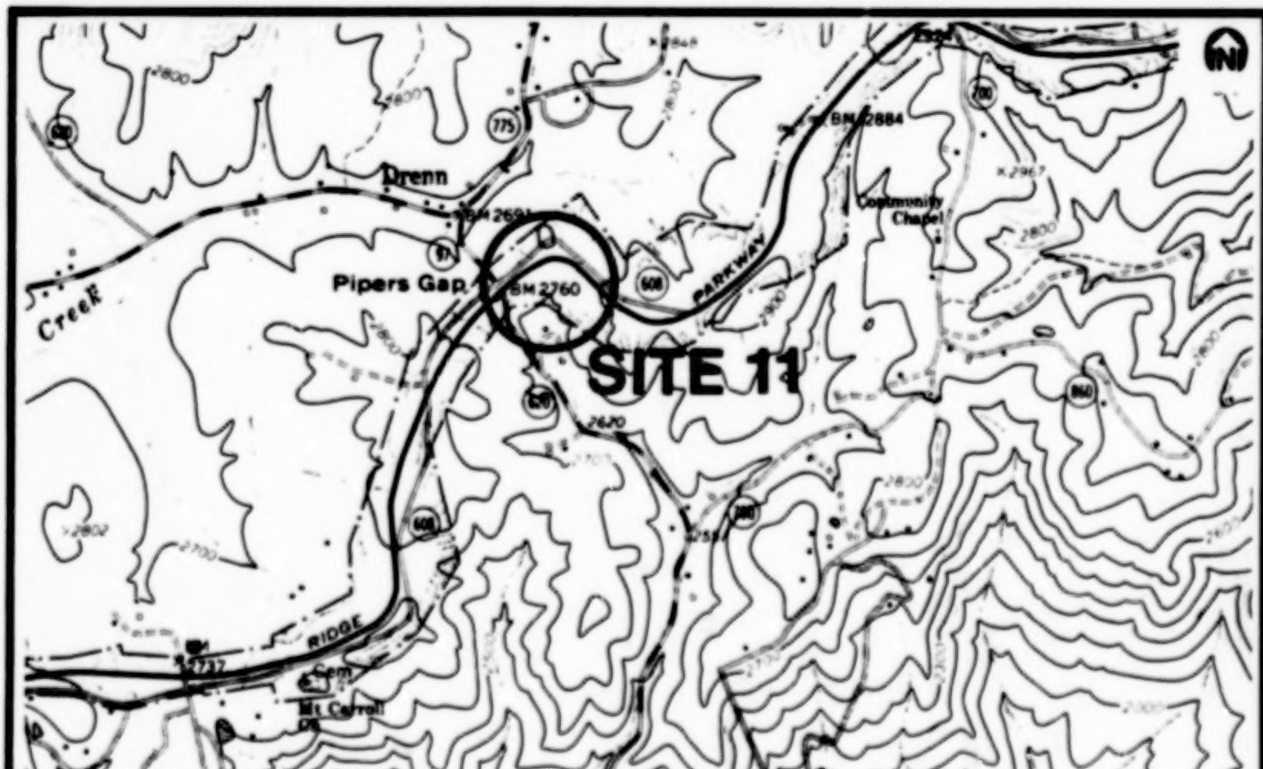


Site 10
Recommended
Improvements

Figure 10B

SITE 11
Existing Conditions

This site consists of single curve located between Mileposts 205.8 and 206.0 some 8 miles southeast of Pipers Gap, Virginia. The site location is presented in the figure below. The width of the Parkway's road surface ranges from 20.5 feet to 23.0 feet in the curve. The grade of the road was measured at 6.3% and the curve's superelevation was determined to be 10.9%. The entire site has a double solid yellow centerline to prohibit passing. Curve warning signs with 35 mph advisory speed plates (W1-2/W13-1) have been installed on the north and south approaches to the curve. There are no structures within the site; however, an overpass for Virginia Secondary Route 620 is located immediately south of Site 11. The traffic volume on this section of the Parkway is estimated to be approximate 1,150 vehicles per day.



Site Location

Blue Ridge Parkway
MP 205.8 to 206.0

Accident History

Ten accidents occurred at this site during the four-year study period; nine of which involved single vehicles. There was one head-on collision between a motorcycle and a car reported at the site which resulted in the death of the driver and passenger on the motorcycle and injuries to two others. The typical accident at this location entails a run-off-the-road incident in the curve and a collision with a fixed object. All of the fixed-object accidents happened as southbound vehicles, travelling at excessive speeds, left the roadway. Vehicles rolled over after leaving the roadway in five of the ten accidents at this location. Injuries occurred in six of the accidents at Site 11. Wet or icy road conditions were contributing factors in half of the accidents. Figure 11A presents the collision diagrams for all accidents that happened at this site during the study period. Pertinent characteristics of all ten accidents reported at Site 11 are shown below.

ACCIDENT DATA

SITE 11: MP 205.8 - 206.0 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
3	5	2	

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
3	4		1		1	1

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2				1	2	2	1	1			1

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
										2		2				1			1		2	2	

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
6	4		

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
5	3		2	

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
7	3		

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
		8				1	1		

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
2		1	7					

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)	1 (2)	2 (5)	2 (4)		5 (11)
Fatality Acc. (No. of Deaths)		1 (2)			1 (2)
Property Damage Only Acc.	2	2			4

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

2

MP. 205.8 to 206.0

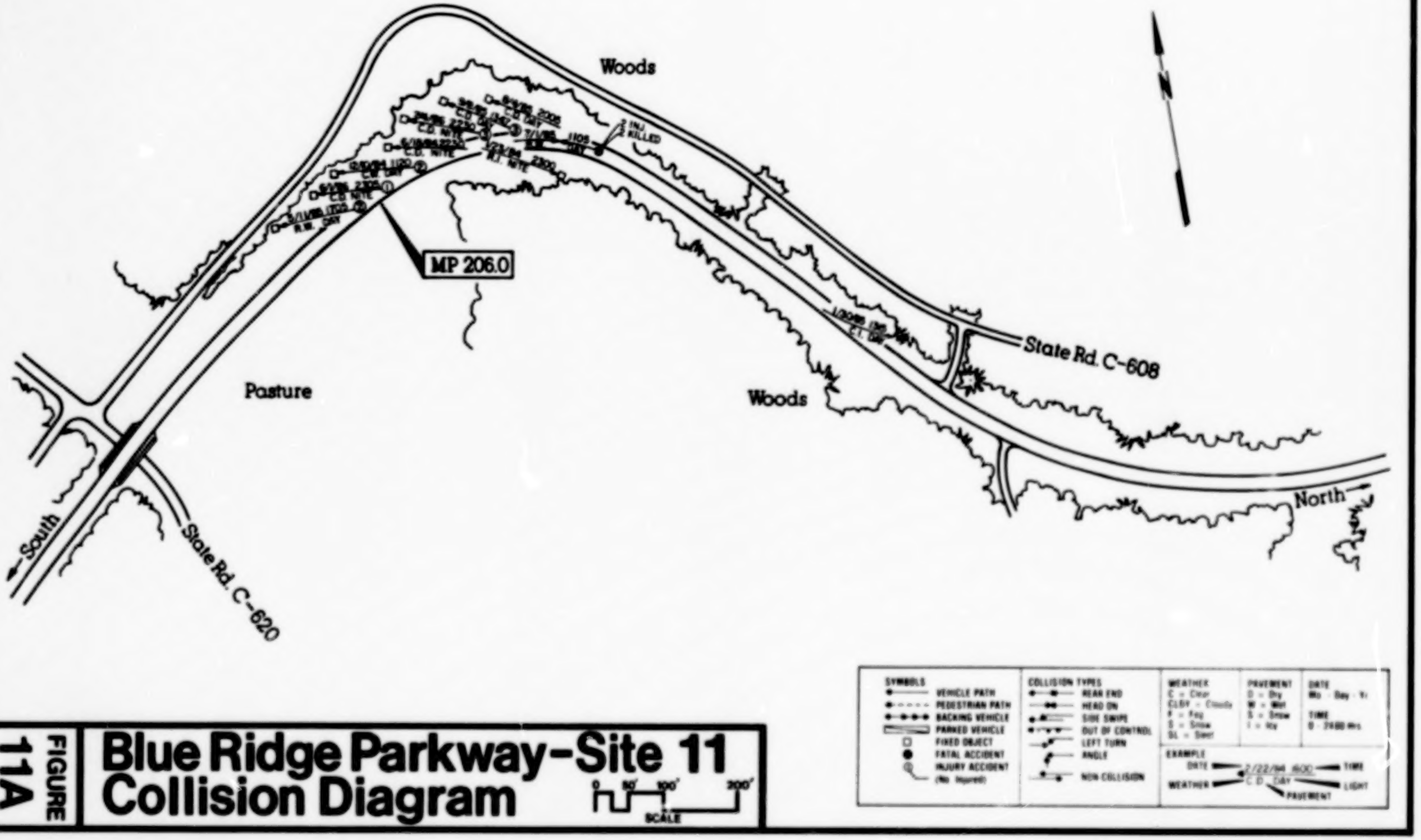


FIGURE 11A

Blue Ridge Parkway-Site 11 Collision Diagram

Site Photographs

Photograph 1: The curve warning sign and 35 mph advisory speed plate located on the north approach are placed approximately 250 feet from the curve.

Photograph 2: The steep embankment on the outside of the curve compounds the severity of most run-off-the-road accidents at this site.

Photograph 3: Sight distance for southbound motorists is limited by the back slope on the inside of the curve.

Photograph 4: These warning signs are properly placed to alert northbound motorists of the upcoming curve.

Photograph 1

Photograph 2

Photograph 3

Photograph 4

Recommended Improvements

The curve at this location has not been adequately identified for southbound motorists. The curve sign is located only 200 feet from the curve and does not provide motorists with enough time to react to the alignment change. The steep embankment in the curve compounds the severity of the accidents by increasing the possibility of a vehicle roll-over.

The recommendations presented below address the safety problems and deficiencies at this location:

List of Improvements	Estimated Cost
● Remove the existing curve warning sign.	$ 100.00
● Install an oversized curve warning sign (W1-2, 36"x36") and a 35 mph advisory speed plate (W13-1, 24"x24") 500 feet from the curve on the north approach.	500.00
● Install 16 white bi-directional delineators in the curve. Locate the delineators as shown in Figure 11B. Solid white, flexible delineators similar to those manufactured by Carsonite are recommended because of their high visibility during daylight hours.	800.00
● Install 500 feet of wooden guardrail (steel-backed) along the outside of the curve.	16,000.00
Total Improvement Costs:	**$17,400.00**
Benefit/Cost Ratio:	**3.34**

- NPS should monitor the accident history at this location for a 3-year period to determine the effectiveness of these improvements. If a reduction in accidents is not achieved, the NPS should consider the use of chevron warning signs to provide additional delineation in this curve.

Hazard Index Calculation Form

Site 11: MP 205.8 - 206.0, Curve north of Piper's Gap

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	2.5	acc/yr	40.0	x	0.164	=	6.56
Accident Rate	7.2	acc/MVE	81.0	x	0.225	=	18.23
Accident Severity	12,930	dollars	71.0	x	0.191	=	13.56
Sight Distance Ratio	.91	(wt. avg.)	40.0	x	0.074	=	2.96
Driver Expectancy	1.5	(wt. avg.)	25.0	x	0.149	=	3.73
Information System Deficiencies	2.33	(wt. avg.)	38.8	x	0.115	=	4.46

Hazard Index: 49.50
Cost of Recommended Improvements: $17,400.00
Cost Factor: 82

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(49.50 x .75) + (82 x .25) = 57.63

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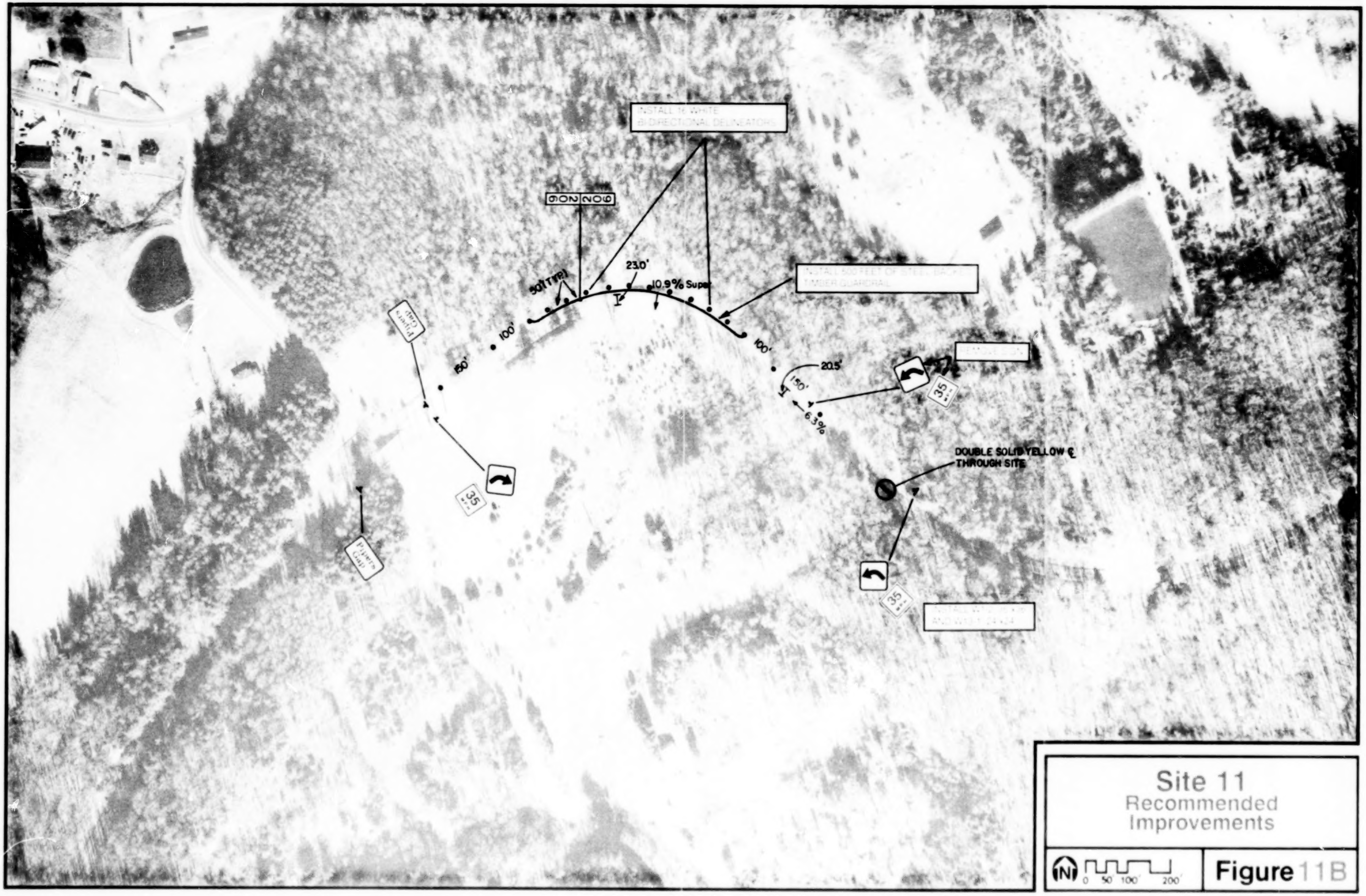
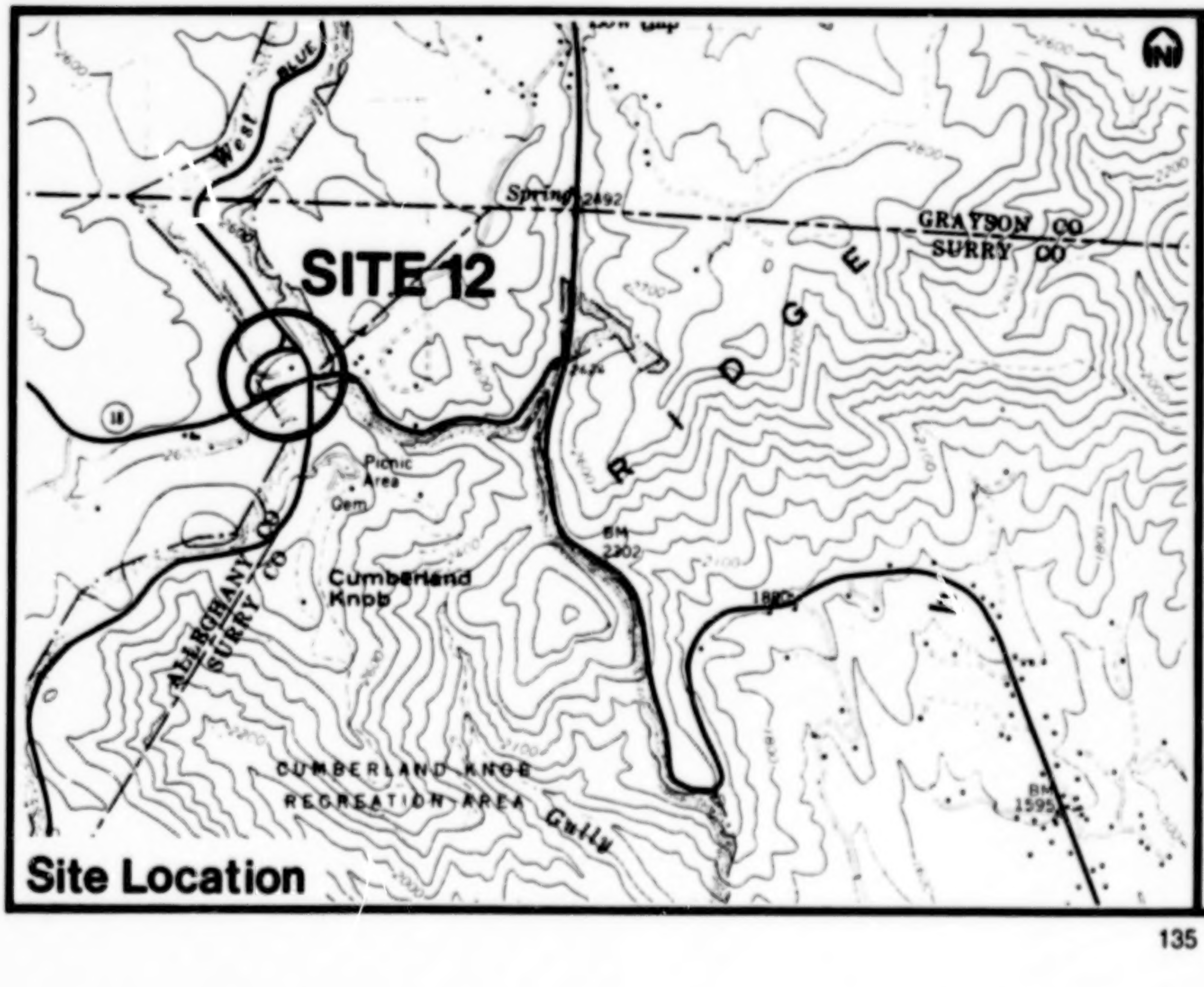

INSTALL 16 WHITE BI-DIRECTIONAL DELINEATORS
209 | 209
50'(TYP.)
23.0'
10.9% Super
INSTALL 500 FEET OF STEEL BACKED TIMBER GUARDRAIL
100'
150'
100'
20.5'
150'
6.3%
REMOVE SIGN
35
35
35
Pipers Gap
Pipers Gap
DOUBLE SOLID YELLOW ℄ THROUGH SITE
INSTALL W1-2 [illegible] AND W13-1 24x24
0 50' 100' 200'

Site 11
Recommended Improvements

Figure 11B

SITE 12
Existing Conditions

This site is a single-quadrant interchange located near Milepost 217.0 in the Cumberland Knob section of the Parkway. The site's general location is shown in the figure at the bottom of this page. The site includes an access ramp with intersections at the Parkway and at North Carolina Primary Highway 18, an overpass for the Primary Route, and an intersection with the access road to the NPS's Cumberland Knob Maintenance Area. The access configuration has formed "T" intersections at the Parkway and at Highway 18. Grades on the Parkway and the access ramp were measured at 4.7% and 1%, respectively. Centerline striping prohibits passing on the Parkway and on the ramp. Access to the Parkway and Highway 18 are controlled by stop signs. The pavement surface, markings, and all signing are in good condition. Figure 12B presents all existing conditions and signing at this location. This figure also presents the results of a turning movement count conducted at the site.



Site Location

Accident History

A total of twelve accidents occurred at Site 12 during the study period. The location of each accident is shown in Figure 12A. Seven accidents happened as a result of excessive speeds in the curve just north of the bridge over Highway 18. The seven accidents resulted in two deaths and nine injuries. Five other accidents during the study period occurred on the exit ramp to Highway 18. All were due to excessive speeds which caused a loss of control and an eventual collision with fixed objects. Two of the fixed-object accidents produced injuries to vehicle occupants. Nine accidents occurred when conditions were clear and dry. Six of the twelve accidents reported at this site took place during the day. A summary of important accident characteristics is presented below.

ACCIDENT DATA

SITE 12: MP 217.1 - 217.3 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
7	2	3	

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
2		2	4		1	3

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		1	1	1		2	3	1	1		2

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
											1	1	1	1	1		2	2	1	2			

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
6	4		2

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
9	2		1	

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
10	2		

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
		11				1			

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
1	2		9					

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)	4 (7)		2 (2)		6 (9)
Fatality Acc. (No. of Deaths)	1 (2)				1 (2)
Property Damage Only Acc.	2	2	1		5

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

1

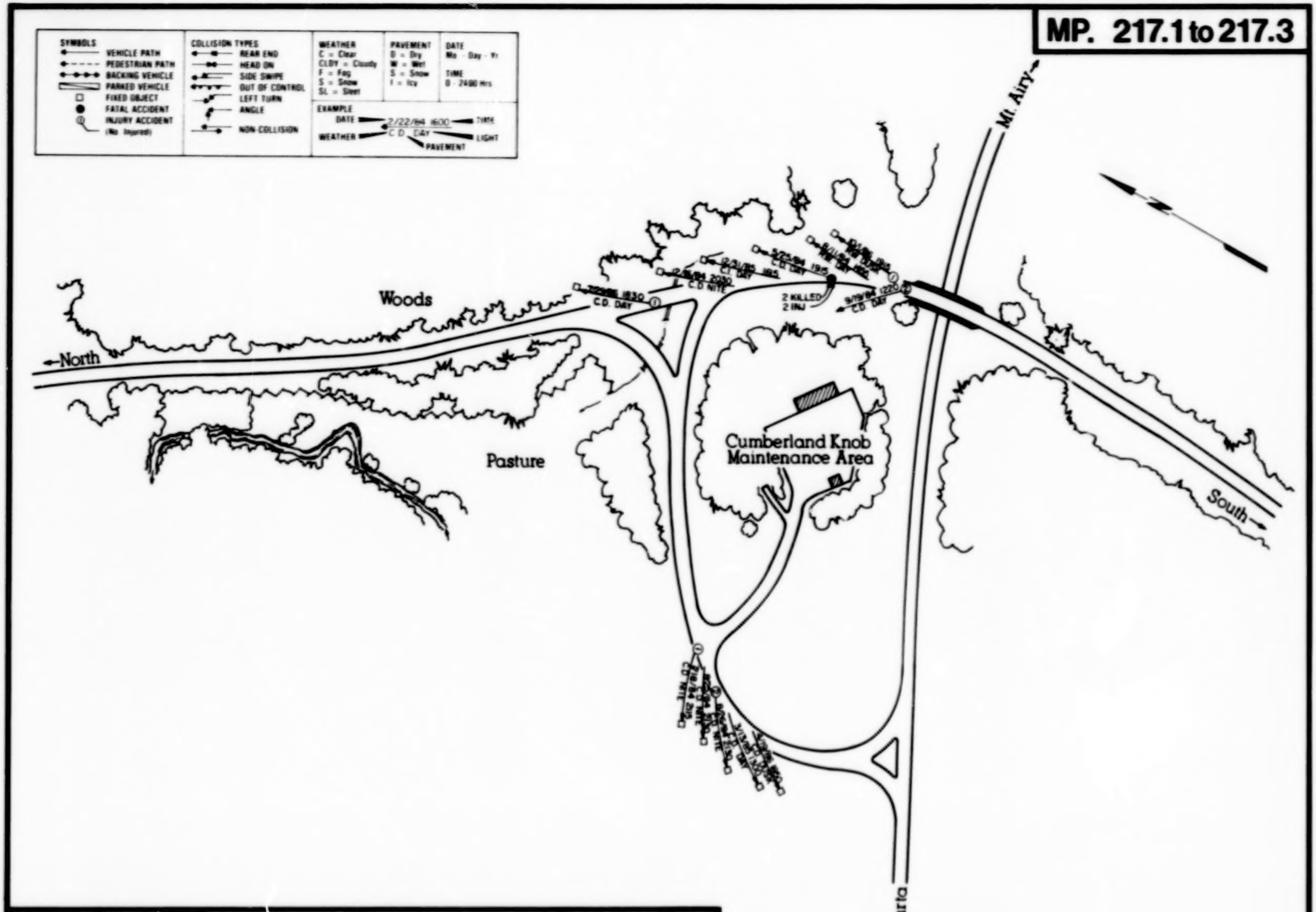


FIGURE 12A

Blue Ridge Parkway-Site 12
Collision Diagram

Site Photographs

Photograph 1: A curve warning sign has been placed on the south approach to alert motorists of the curve ahead.

Photograph 2: Several accidents reported at this site during the study period involved vehicles which ran off the road in the curve.

Photograph 3: The vegetation at the corner of this intersection blocks the view of the side road for approach traffic.

Photograph 4: A curve warning sign and a 15 mph advisory speed plate are used to warn motorists of the change in alignment on the ramp. Additional delineation through the curve is necessary to increase the driver's awareness of this alignment change.

Photograph 1

Photograph 2

Photograph 3

Photograph 4

Recommended Improvements

Although both curves at this site have warning signs, run-off-the-road accidents still occur. The curves are visually misleading to the motorist. Additional guidance through the use of reflectorized delineators will alert the motorist to the conditions at this site.

The recommended improvements presented below address the safety problems and deficiencies at this site:

List of Improvements	Estimated Cost
Install 12 white, flexible delineators in the curve on the exit ramp. Locate the delineators as shown in Figure 12B.	$ 600.00
Install a turn warning sign (W1-1, 30"x30") and a 15 mph advisory speed plate (W13-1, 18"x18") on the exit ramp as shown in Figure 12B.	300.00
Replace the 30"x30" curve warning sign of the south approach with a larger curve warning sign (W1-2, 36"x36").	300.00
Install 13 white, flexible delineators in the curve north of the Highway 18 overpass as shown in Figure 12B.	650.00
Install painted stop bars adjacent to the stop signs at this site.	400.00
Remove the trees and shrubs on the southwest corner of the Parkway junction that block the driver's view of the south approach from the stop sign.	2,000.00
Install a 15 mph advisory exit speed sign (W13-2, 24"x30") 250 feet north of the junction and a state route marker with a directional arrow (M1-6, M6-2) on the nose of the median island.	800.00
Install 4" white shoulder stripes on the exit ramp.	750.00
Remove the existing 24"x24"x24" yield signs at this interchange and install standard 36"x36"x36" yield signs on the right side of the ramps as shown on Figure 12B.	800.00
Install a 20 mph advisory exit speed sign (W13-2, 24"x30") on Highway 18 approximately 250 feet in advance of the entrance ramp.	300.00
Remove the curbing on the median island at the Parkway ramp junction.	3,000.00
Total Improvement Costs:	**$ 9,900.00**
Benefit/Cost Ratio:	**3.49**

- NPS should monitor the accident history at this location for a 3-year period to determine the effectiveness of these improvements. If a reduction in accidents is not achieved, NPS should consider the use of chevron warning signs in the curves at this site.

Hazard Index Calculation Form

Site 12: MP 217.1 - 217.3, Junction State Route 18

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	3.0	acc/yr	44.0	x	0.164	=	7.22
Accident Rate	8.39	acc/MVE	91.0	x	0.225	=	20.48
Accident Severity	12,400	dollars	69.0	x	0.191	=	13.18
Sight Distance Ratio	1.06	(wt. avg.)	30.0	x	0.074	=	2.22
Driver Expectancy	3.83	(wt. avg.)	63.8	x	0.149	=	9.51
Information System Deficiencies	3.5	(wt. avg.)	58.3	x	0.115	=	6.70

Hazard Index:	59.31
Cost of Recommended Improvements:	$9,900.00
Cost Factor:	90

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(59.31 x .75) + (90 x .25) = 66.98

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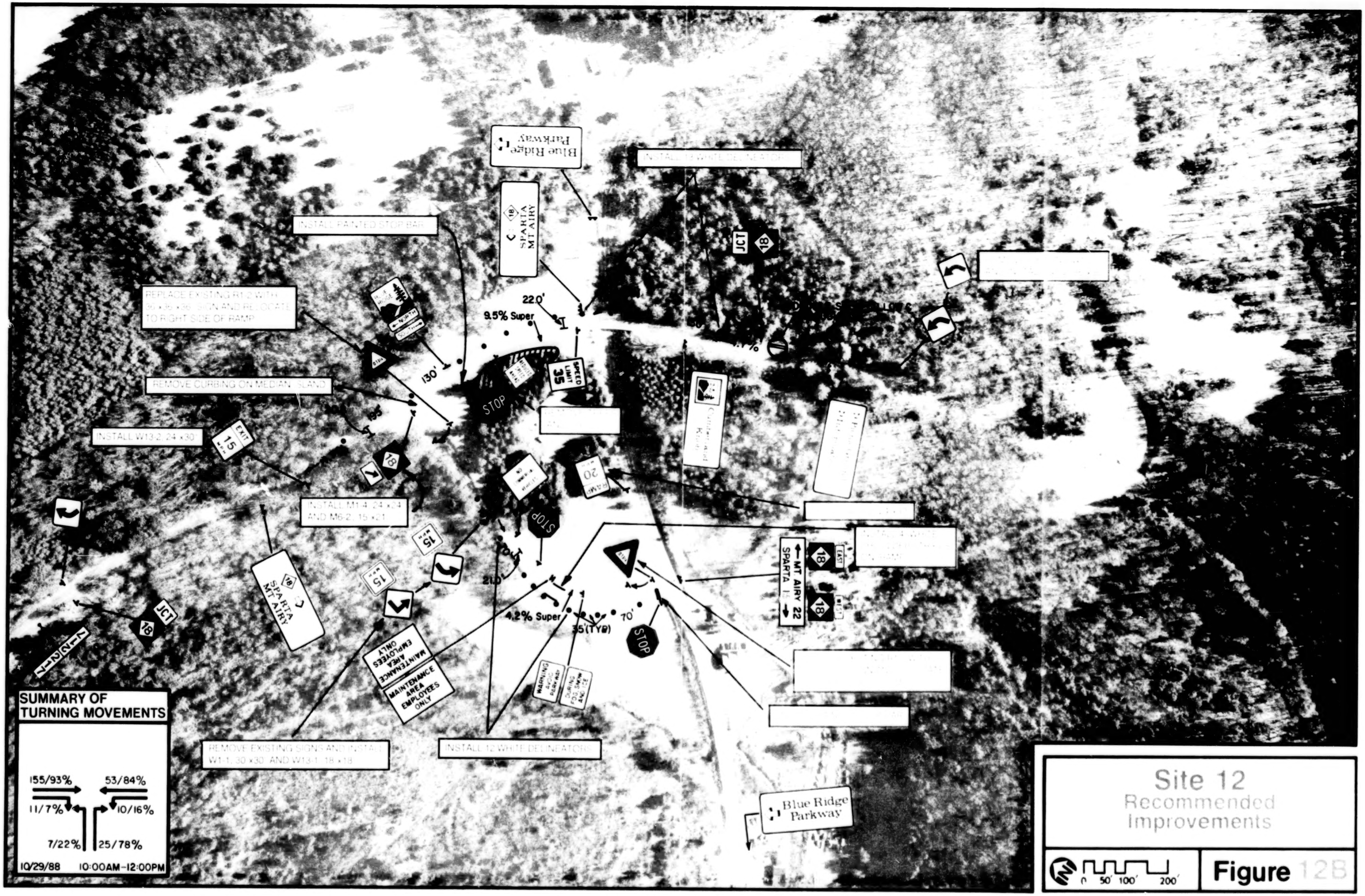


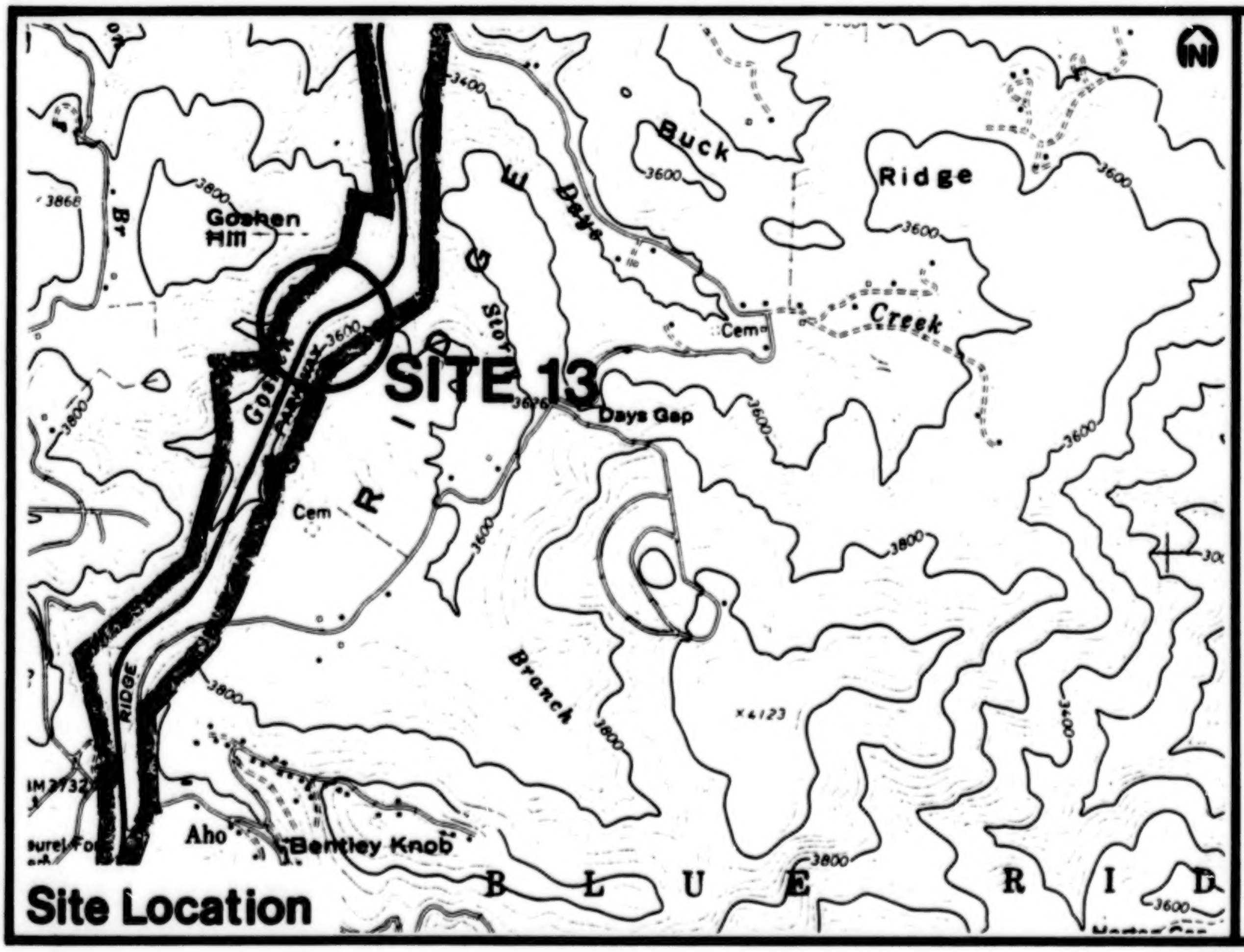
Site 12
Recommended
Improvements

Figure 12B

SITE 13

Existing Conditions

This site consists of a reverse curve located near Milepost 287.0 some 4.5 miles northeast of Blowing Rock, North Carolina. The general location of this site is presented in the map below. The grades at the site were field measured and range from 7 to 8%. The superelevation in the southernmost curve was measured at 10.9%. The width of the Parkway varies slightly between 20.5 and 21.5 feet. The pavement surface in this site is in good condition. A double solid yellow centerline has been installed to prohibit passing through the curves. The only sign that exists within the site is a "Beware of Sudden Icing" warning sign near the south end of this location. A large culvert has been installed at the north end of the site where the Parkway crosses a small stream. The traffic on this section of the Parkway is estimated to be approximately 1,020 vehicles per day.



Site Location

Blue Ridge Parkway MP 286.9 to 287.1

Accident History

Thirteen accidents were recorded at this site during the four-year study period. Figure 13A presents the collision diagrams for each of the accidents. Eleven accidents happened during December, January, and February under icy road conditions. Vehicle roll-overs occurred in five of the eleven icy-road accidents. Icy roads also contributed to two fixed-object collisions in which vehicles struck the stone bridge at the north end of the site. The vertical rock cut slope on the east side of the Parkway was struck in four other fixed-object accidents. Two of the three multi-vehicle accidents at Site 13 were sideswipes. Four accidents produced seven injuries. Seven of the accidents at this site happened during low-light conditions. A composite summary of the thirteen accidents reported at this site is presented below.

ACCIDENT DATA

SITE 13: MP 286.9 - 287.1 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
7		5	1

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
3		3	5		1	1

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
5	4					1	1				2

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	1					1					2		1	1			1		2	1	2		1

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
6	6		1

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
2			11	

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
11	2		

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
		9			3	1			

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
11		1	1					

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)	2 (4)		1 (2)	1 (1)	4 (7)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.	5		4		9

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

0

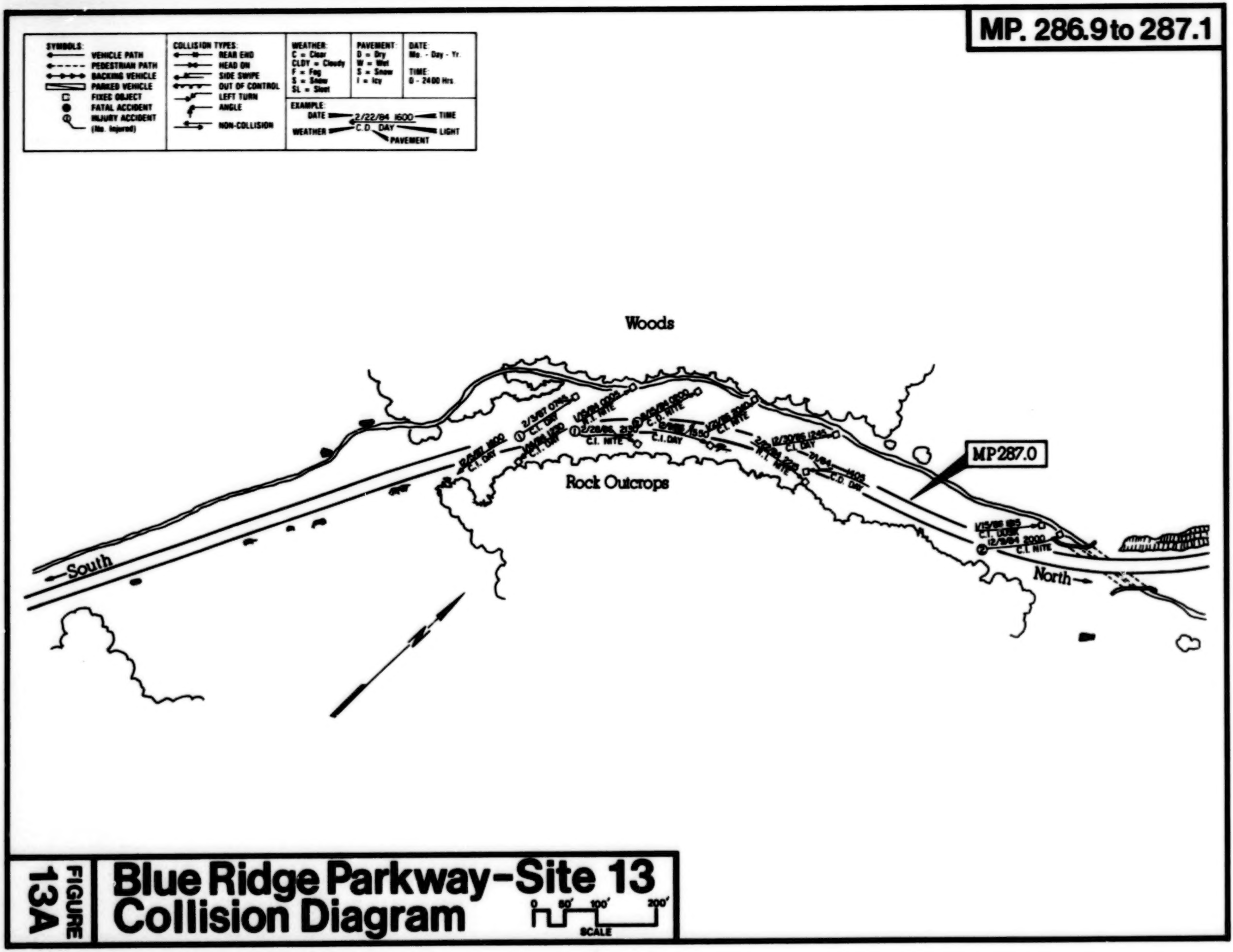


FIGURE 13A **Blue Ridge Parkway-Site 13 Collision Diagram**

0 50' 100' 200'
SCALE

Site Photographs

Photograph 1: A special "Beware of Sudden Icing" warning sign has been installed at this site to advise motorists of potentially hazardous driving conditions.

Photograph 2: The vertical rock cut slope on the east side of the Parkway shades the pavement from the sun during the winter and is partially responsible for the icy-road conditions that often occur at this site.

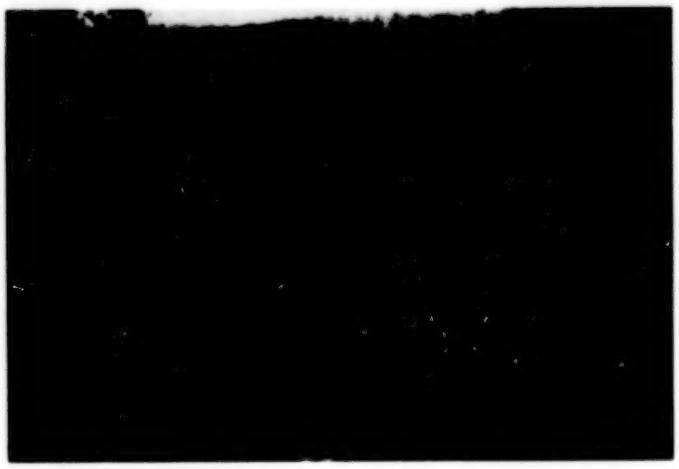
Photograph 3: This photograph shows the winding road at the north end of the site. Notice the sight distance obstruction caused by the rock cut slope.

Photograph 4: Two accidents during the study period occurred when vehicles left the roadway and entered the creek at the north end of the site.

Photograph 1

Photograph 2

Photograph 3



Photograph 4

Recommended Improvements

This site has an extensive accident history during icy road conditions. Vehicles involved in accidents during such conditions collided with the vertical rock cut slope in the curve or ran off the road and into the creek. The long tangent section of road immediately south of the site encourages excessive approach speeds by the northbound traffic. The maximum safe speed for these curves is 45 mph.

The recommendations shown below address the site deficiencies:

List of Improvements	Estimated Cost
● Remove the undersized "Beware of Sudden Icing" sign on the south approach.	$ 100.00
● Install a "Beware of Sudden Icing" warning sign (W8-10, 30"x30") on both approaches to this site. Locate the signs 750 feet from the curve on the south approach and 750 feet north of the bridge on the north approach as shown in Figure 13B. Remove these signs during the summer months.	600.00
● Install a hinged "Ice on Pavement" warning sign (W8-10, 36"x36") on both approaches. Locate the signs 500 feet south of the curve on the south approach and 500 feet north of the bridge on the north approach. These signs should be accompanied with an amber flashing light mounted on top of sign post. Remove the signs during the summer months.	2,000.00
● Install 1,100 feet of wooden guardrail (steel-backed) along the outside of the curve. Mount 3" white reflectors on the face of the guardrail at 50-foot intervals.	35,000.00
● NPS should consider the use of a course-graded asphalt or a high friction chip and seal application for the pavement in this area. Winter-time surveillance and sanding of this area should be a high priority. (No Cost Provided.)	
Total Improvement Costs:	**$37,700.00**
Benefit/Cost Ratio:	**1.02**

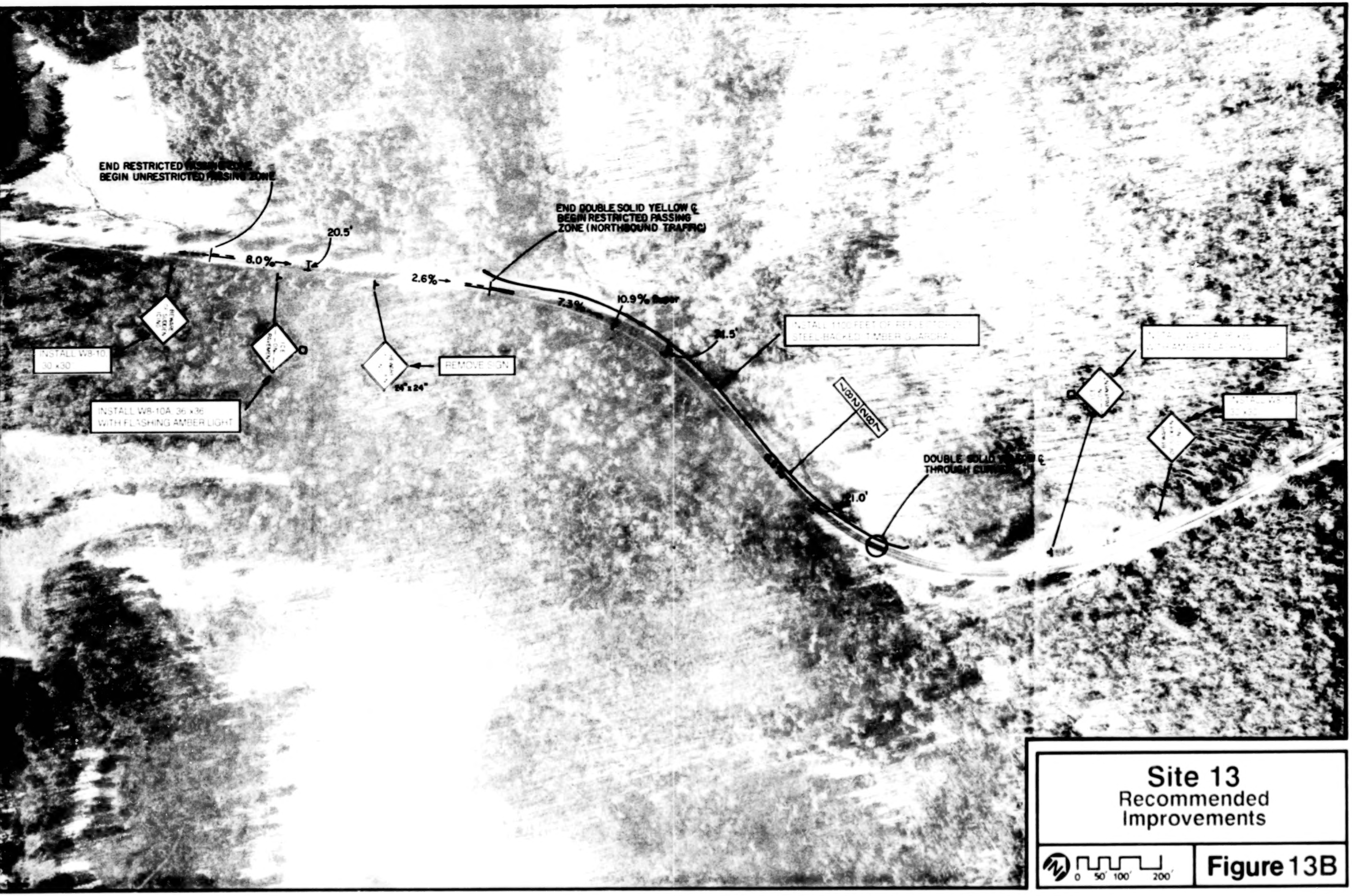
Hazard Index Calculation Form

Site 13: MP 286.9 - 287.1, Curve north of Aho Gap

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	3.25	acc/yr	46.0	x	0.164	=	7.54
Accident Rate	10.49	acc/MVE	100.0	x	0.225	=	22.50
Accident Severity	12,292	dollars	68.0	x	0.191	=	12.99
Sight Distance Ratio	.51	(wt. avg.)	99.0	x	0.074	=	7.33
Driver Expectancy	2.17	(wt. avg.)	36.2	x	0.149	=	5.39
Information System Deficiencies	1.33	(wt. avg.)	22.2	x	0.115	=	2.55

Hazard Index:	58.30
Cost of Recommended Improvements:	$37,700.00
Cost Factor:	60

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(58.30 x .75) + (60 x .25) = 58.73

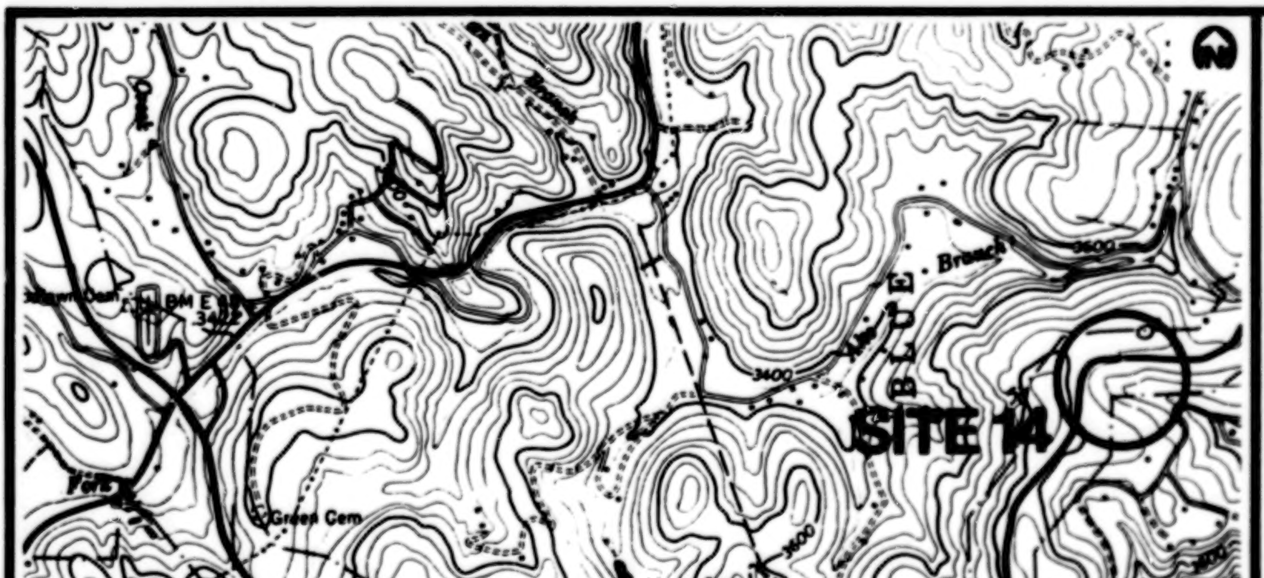


Site 13
Recommended
Improvements

Figure 13B

SITE 14
Existing Conditions

This site includes a sharp curve located between Parkway Mileposts 289.2 and 289.4 approximately 2.5 miles northeast of Blowing Rock, North Carolina. The site's location is shown on the map below. Site 14 is located in a relatively open area of the Parkway where adjacent lands are used for pasture. Grades through the site range from 4.3 to 5.9% and the superelevation of the curve was measured to be 11.1%. The pavement surface at this location is in good condition. The centerline striping prohibits passing through the curve and on its approaches. Curve warning signs with 30 mph advisory speed plates have been placed on both approaches to the curve. The traffic volume on this portion of the Parkway is estimated to be approximately 1,020 vehicles per day. All existing conditions at this location are shown in Figure 14B.



Site Location

**Blue Ridge Parkway
MP 289.2 to 289.4**

Accident History

A total of eight accidents, including two fatality accidents, were recorded at this site during the study period. One of the fatality accidents was a head-on collision that resulted in the death of both drivers. The other fatality accident occurred when a northbound motorist lost control in the curve and rolled over. Four other accidents at this location produced injuries when vehicles left the roadway in the curve. Trees were struck in the three fixed-object accidents recorded at this site. Five accidents occurred when conditions were clear and dry, and four took place at night. Excessive speed was a contributing factor in at least five incidents at this site. The location of each accident at Site 14 is presented in Figure 14A. A summarization of pertinent accident data is shown below.

ACCIDENT DATA

SITE 14: MP 289.2 - 289.4 ACCIDENT PERIOD 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
	1	7	

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
2	2		2		1	1

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		2	1	1	1	1	1		1		

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2	2										1					2	1						

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
4	4		

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
5	3			

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
6	1		1

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
		3				4	1		

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
2		1	5					

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)		1 (2)	3 (5)		4 (7)
Fatality Acc. (No. of Deaths)			2 (3)		2 (3)
Property Damage Only Acc.			2		2

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

3

MP. 289.2 to 289.4

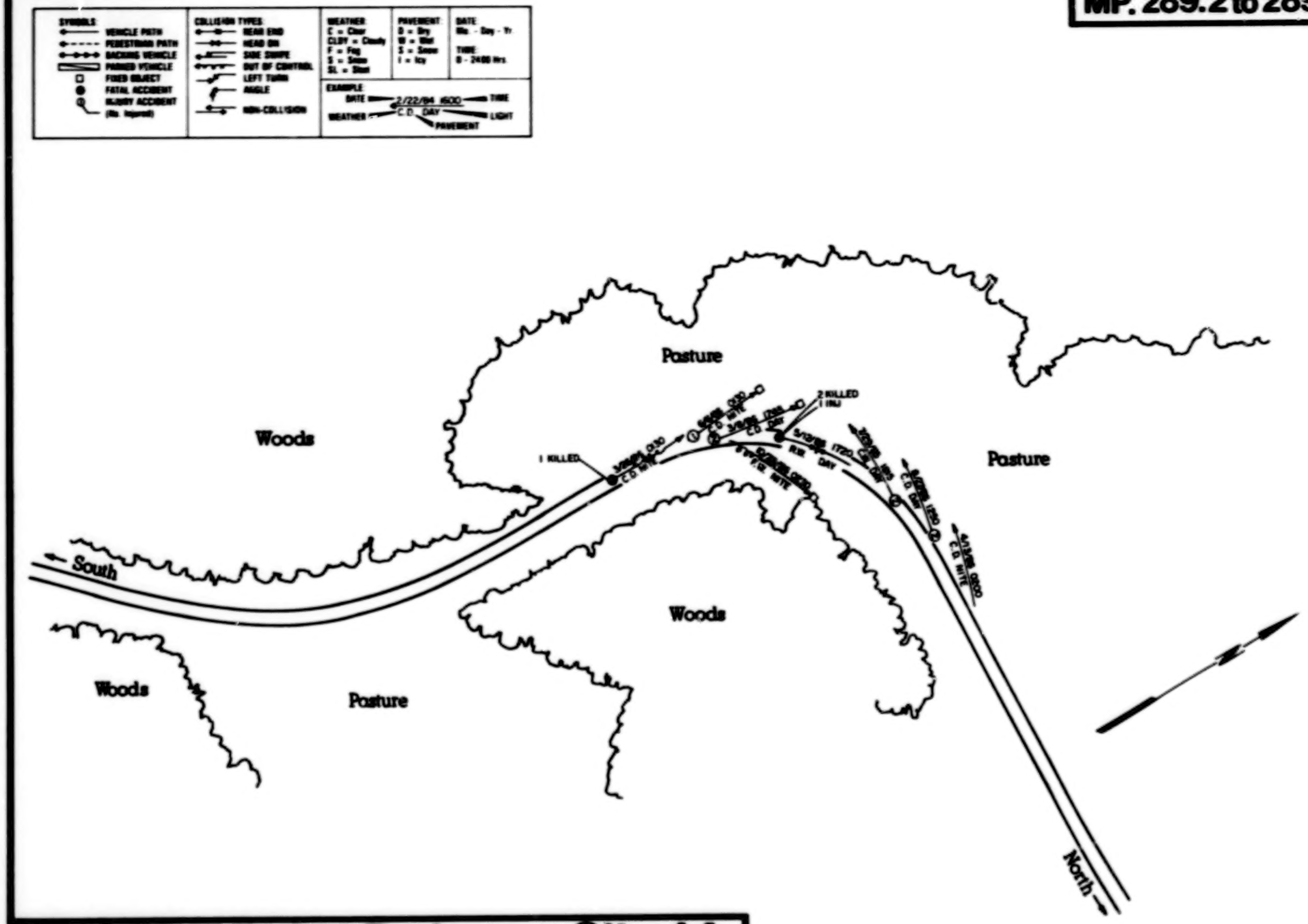


FIGURE 14A

Blue Ridge Parkway–Site 14
Collision Diagram

Site Photographs

Photograph 1: The curve warning signs should be replaced with turn warning signs which are appropriate for curves with maximum safe speeds of 30 mph or less.

Photograph 2: The trees on the outside of the curve limit sight distance for motorists on the Parkway.

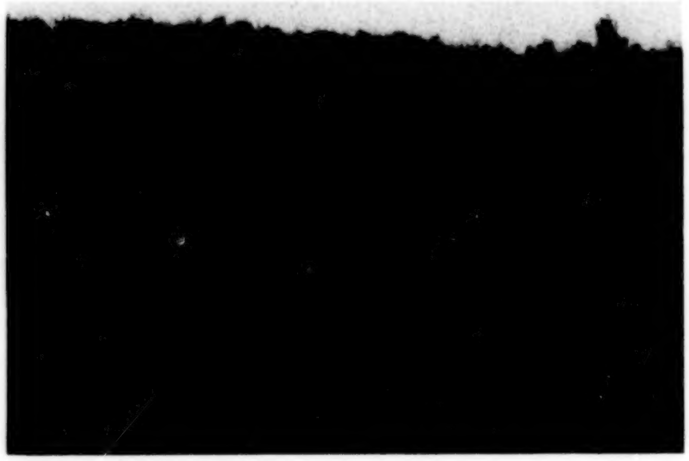
Photograph 3: Run-off-the-road accidents at this site often result in collisions with trees located on the outside of the curve.

Photograph 4: This photograph of the north approach at this site shows that the warning signs are located only 200 feet from the curve.

Photograph 1

Photograph 2

Photograph 3



Photograph 4

Recommended Improvements

Visitors appear to have difficulty identifying the curve even though curve warning signs exist on both approaches. The warning sign on the north approach is located too close (200 feet) to the curve to be effective. Excessive vehicle speed was also a contributing factor to most of the accidents at this site. The severity of the accidents is compounded when vehicles leave the road and encounter fixed objects.

The recommended improvements listed below address the safety problems and deficiencies at this location:

List of Improvements	Estimated Cost
• Remove the curve warning signs at this site and install a turn warning sign (W1-1, 36"x36") and a 30 mph advisory speed plate (W13-1, 24"x24") on both approaches to the curve.	$ 1,000.00
• Install 15 white bi-directional delineators along the outside of the curve as shown in Figure 14B. Solid white, flexible delineators similar to those manufactured by Carsonite are recommended because of their high visibility during daylight hours.	750.00
• Remove the trees and shrubs located on the inside of the curve that block the driver's view of the road alignment.	3,000.00
Total Improvement Costs:	**$ 4,750.00**
Benefit/Cost Ratio:	**4.10**

- NPS should monitor the accident history at this location for a 3-year period to determine the effectiveness of these improvements. If a reduction in accidents is not achieved, the NPS should consider using chevron warning signs to provide additional delineation in this curve.

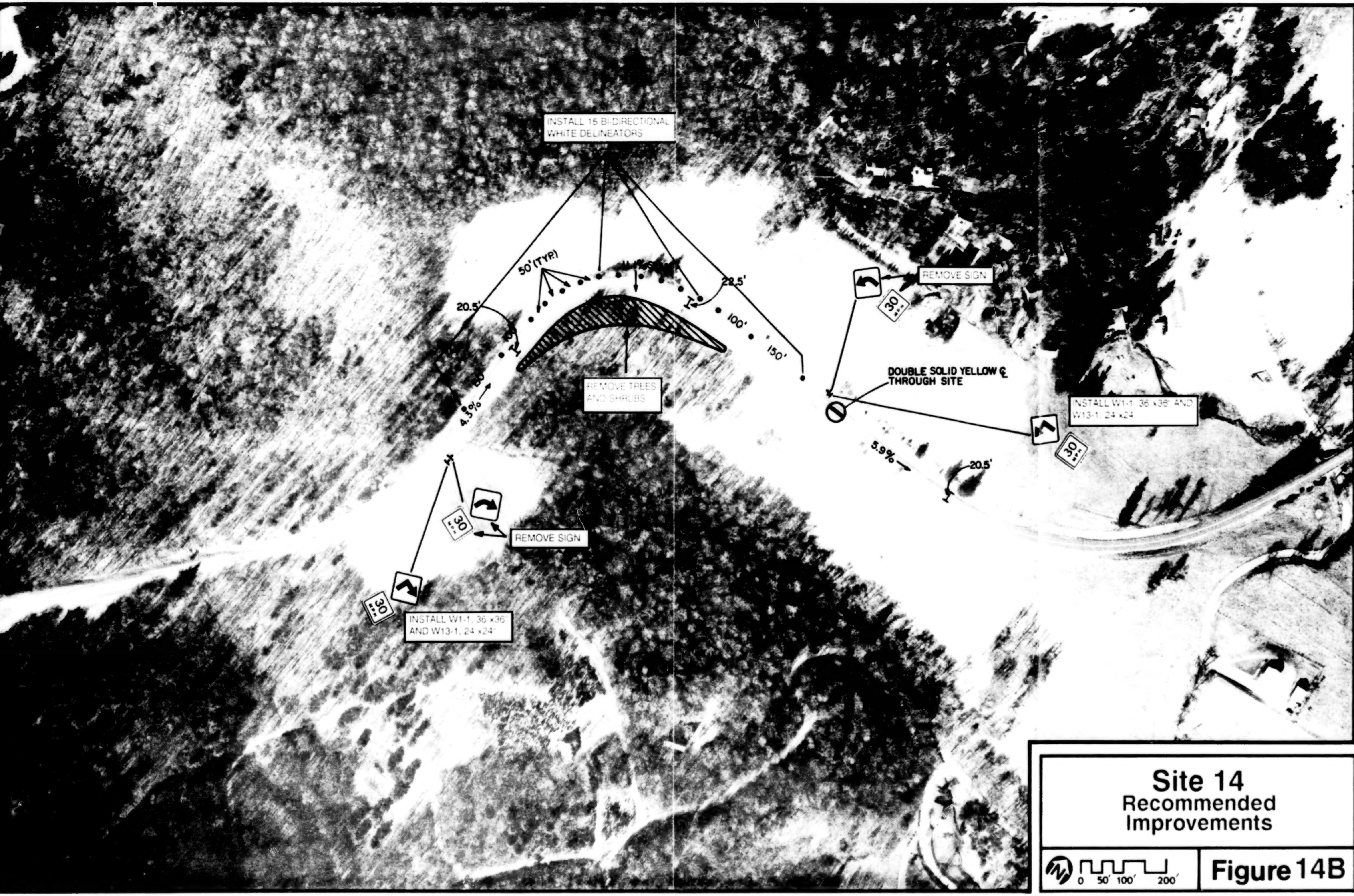
Hazard Index Calculation Form

Site 14: MP 289.2 - 289.4, Curves north of Raven Rock Overlook

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	2.0	acc/yr	37.0	x	0.164	=	6.07
Accident Rate	6.45	acc/MVE	79.0	x	0.225	=	17.78
Accident Severity	12,925	dollars	70.0	x	0.191	=	13.37
Sight Distance Ratio	.53	(wt. avg.)	96.0	x	0.074	=	7.10
Driver Expectancy	1.83	(wt. avg.)	30.5	x	0.149	=	4.54
Information System Deficiencies	1.67	(wt. avg.)	27.8	x	0.115	=	3.20

Hazard Index:	52.06
Cost of Recommended Improvements:	$4,750.00
Cost Factor:	95

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(52.06 x .75) + (95 x .25) = 62.80


INSTALL 15 BI-DIRECTIONAL WHITE DELINEATORS
50'(TYP.)
20.5'
22.5'
100'
150'
50
4.3%
REMOVE TREES AND SHRUBS
REMOVE SIGN
30
DOUBLE SOLID YELLOW ℄ THROUGH SITE
INSTALL W1-1, 36"x36" AND W13-1, 24"x24"
5.9%
20.5'
30
REMOVE SIGN
30
INSTALL W1-1, 36"x36" AND W13-1, 24"x24"
30
0
50'
100'
200'

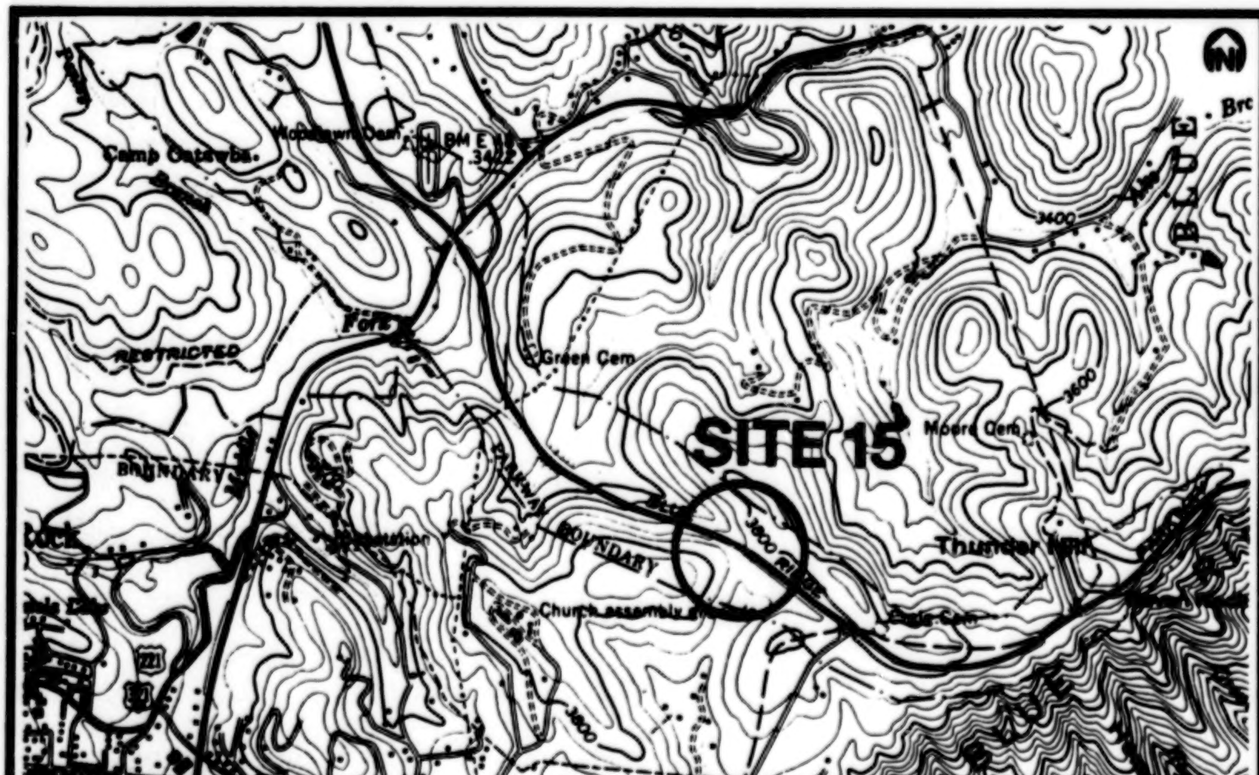
Site 14
Recommended Improvements

Figure 14B

SITE 15

Existing Conditions

This site consists of a gentle, reverse curve located near Milepost 291.0 approximately one mile northeast of Blowing Rock, North Carolina. The location of the site is shown on the map that follows this narrative. The Parkway grades through the site vary from 2.5 to 8.7%. The superelevation in the northernmost curve measured at 4.7%. The width of the Parkway's road surface ranges from 20.5 to 21.3 feet through this site. The centerline striping prohibits passing through the curves. The only sign present in the site is a special warning sign stating "Ice on Pavement." An amber flashing light has been placed on the sign to emphasize that weather may cause potentially hazardous road conditions. There are no structures or intersections within the site. Traffic volumes are estimated to be approximately 1,020 vehicles per day on this segment of the Parkway.



Site Location

Blue Ridge Parkway
MP 290.9 to 291.1

Accident History

Six accidents were recorded at this site during the four-year study period. All of the accidents occurred when freezing rain was falling producing extremely icy road conditions. Five of the six accidents at the site were fixed-object collisions with roadside vegetation. One pedestrian-related accident was reported at Site 15. The pedestrian was struck and killed by a vehicle that was out of control due to the icy road. All other accidents at the site were minor and did not produce injuries. The location of the accidents at this site are shown in Figure 15A. A composite summary of important accident characteristics is presented below.

ACCIDENT DATA

SITE 15: MP 290.9 - 291.1 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
6			

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
		4			2	

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
4										2	

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
						2	2											1	1				

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
4	2		

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
			6	

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
	6		

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
		5	1						

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
6								

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)					0
Fatality Acc. (No. of Deaths)	1 (1)				1 (1)
Property Damage Only Acc.	5				5

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

0

MP. 290.9to 291.1

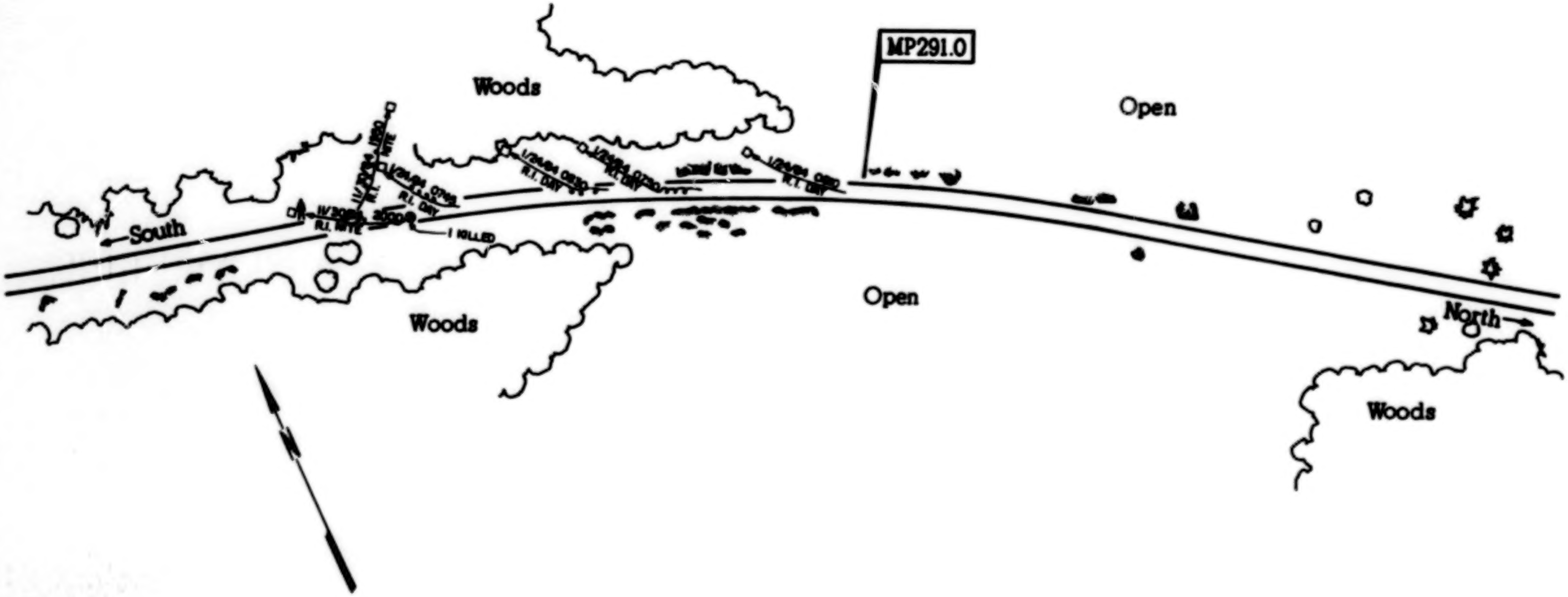


FIGURE 15A

Blue Ridge Parkway–Site 15 Collision Diagram

Site Photographs

Photograph 1: The Parkway is approximately 21 feet wide and changes grades from 2.5% to 8.5% at MP 291.

Photograph 2: The vegetation growing on the east side of the Parkway shades the road and contributes to the icy road conditions commonly experienced at this site.

Photograph 3: This photograph depicts the gentle road alignment of the Parkway at the top of Green Hill.

Photograph 4: An "Ice on Pavement" warning sign has been installed north of the site to alert drivers to the hazardous road conditions in the winter. The amber flashing light (vandalized in this photograph) is used to reinforce the warning sign's message.

Photograph 1

Photograph 2

Photograph 3

Photograph 4

Recommended Improvements

This section of the Parkway has a history of accidents during icy-road conditions. The design of the road does not appear to be deficient. Additional warning of potentially icy-road conditions is needed since the sole warning sign is undersized and its flashing light is broken.

The following improvements address the deficiencies at this site:

List of Improvements	Estimated Cost
● Remove the existing undersized "Ice on Pavement" warning sign and flashing light.	$ 100.00
● Install a "Beware of Sudden Icing" warning sign (W8-10, 30"x30") on both approaches to this site. Locate one sign 750 feet north of the milepost marker on the north approach and the other at MP 291.4. Remove the signs during the summer months.	600.00
● Install a hinged "Ice on Pavement" warning sign (W8-10A, 36"x36") with an amber flashing light on both approaches to this site. Locate one sign 500 feet north of the milepost marker on the north approach and the other at MP 291.3. Remove both signs during the summer months.	2,000.00
● NPS should consider the use of a course-graded asphalt or a high friction chip and seal on the pavement in this area. (No Cost Provided.)	
Total Improvement Costs:	**$ 2,700.00**
Benefit/Cost Ratio:	**1.66**

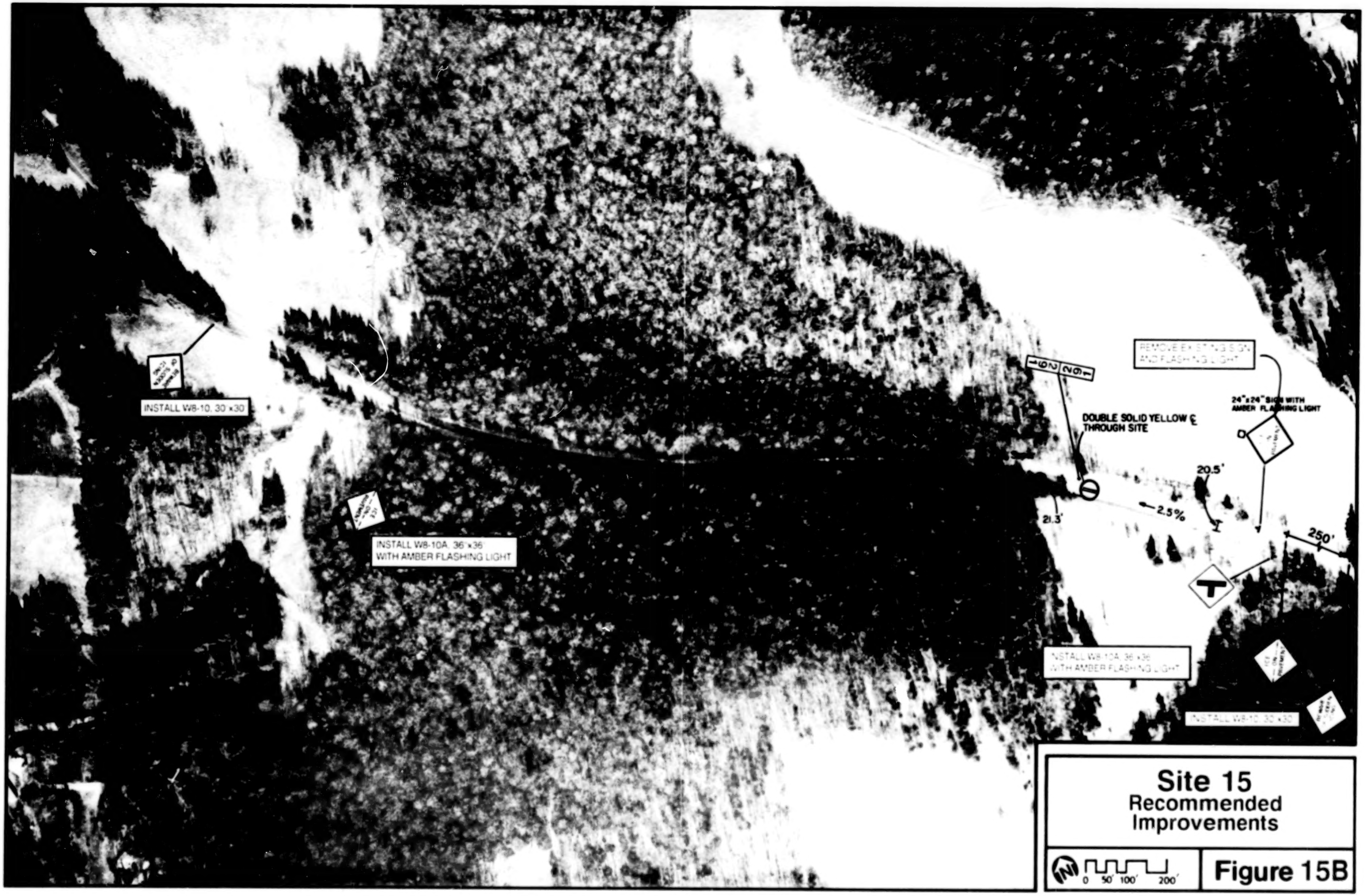
Hazard Index Calculation Form

Site 18: MP 290.9 - 291.1, Thunder Hill

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	1.5	acc/yr	33.0	x	0.164	=	5.41
Accident Rate	4.84	acc/MVE	65.0	x	0.225	=	14.63
Accident Severity	10,500	dollars	63.0	x	0.191	=	12.03
Sight Distance Ratio	1.17	(wt. avg.)	23.0	x	0.074	=	1.70
Driver Expectancy	1.83	(wt. avg.)	30.5	x	0.149	=	4.54
Information System Deficiencies	2	(wt. avg.)	33.3	x	0.115	=	3.83

Hazard Index:	42.14
Cost of Recommended Improvements:	$2,700.00
Cost Factor:	97

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(42.14 x .75) + (97 x .25) = 55.86

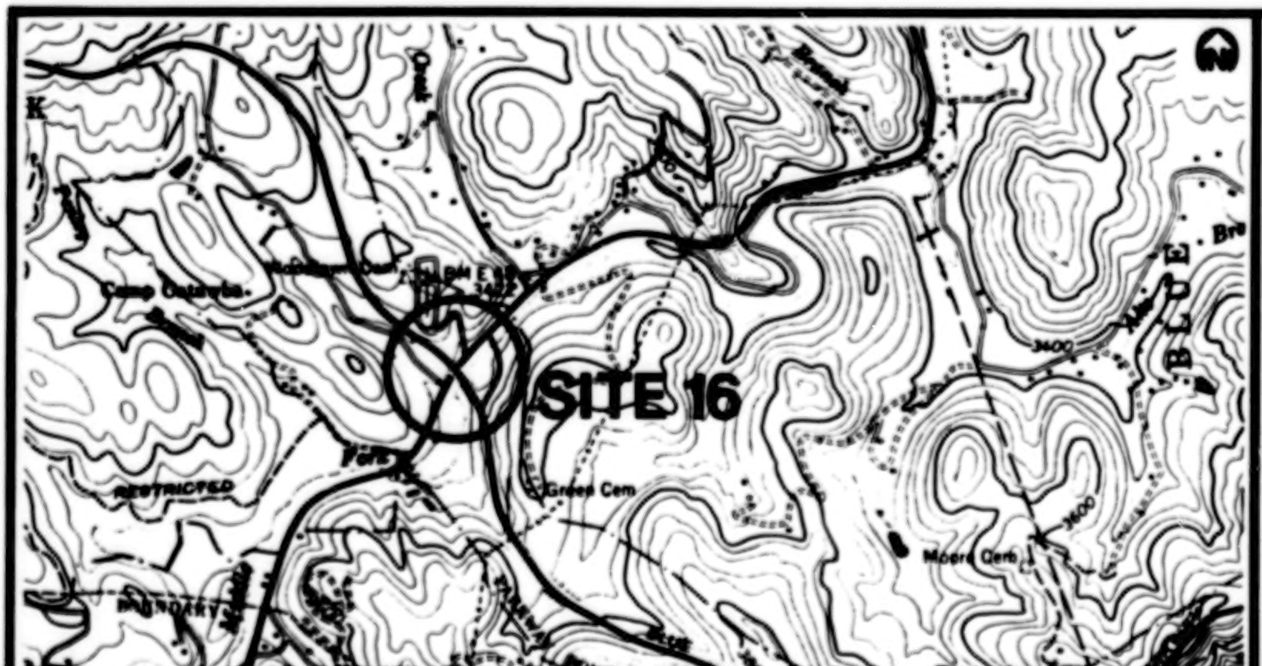


Site 15
Recommended Improvements

Figure 15B

SITE 16
Existing Conditions

Site 16 consists of a two-quadrant interchange located near Parkway Milepost 292.0 just outside Blowing Rock, North Carolina. The site includes the access ramps to U.S. Highway 221/321, an overpass structure, and "T" intersections at the Blue Ridge Parkway. U.S. Highway 221/321 is a major north-south route and connects Blowing Rock with the nearby community of Boone. The site's location is shown on the map at the bottom of this page. Grades on the Parkway are approximately 7% and average between 4 and 7.5% on the access ramps. The width of the Parkway's road surface is typically 21.0 feet through this site. The width of the pavement on the ramps varies from 20.5 to 24.0 feet. Right turn lanes have been provided on U.S. 221/321. Access to and from the Parkway is controlled by either stop or yield signs. All existing conditions and the results of two-hour turning movement counts taken at both intersections on the Parkway are presented in Figure 16B.



Site Location

Blue Ridge Parkway MP 291.7 to 291.9

Accident History

The interchange with U.S. 221 was the site of twelve accidents during the study period. Figure 16A shows the location and pertinent data for all twelve accidents at the site. Five accidents involved more than one vehicle and included four angle collisions, a three-car collision, and a rear-end collision. Four of the multi-vehicle collisions occurred at the junction of the Parkway and the south exit ramp. The junction of the Parkway and the north exit ramp was the site of one angle collision and four single-vehicle accidents during the study period. Four of the seven single-vehicle accidents occurred during snowy or icy road conditions. Eight of the twelve accidents took place during the day when conditions were clear and dry. A summary of the twelve accidents which occurred during the study period is shown below.

ACCIDENT DATA

SITE 16: MP 291.7 - 291.9 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
1	2	5	4

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
2	2	3	3	1		1

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1				1	1	2	2		2	2	1

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1						1	3					2		1	1			1				1	1

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
8	4		

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
8		1	3	

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
10	1	1	

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
4	1	5				2			

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
3		2	3	4				

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)	1 (1)		1 (1)	2 (3)	4 (5)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.		2	4	2	8

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

0

MP. 291.7 to 291.9

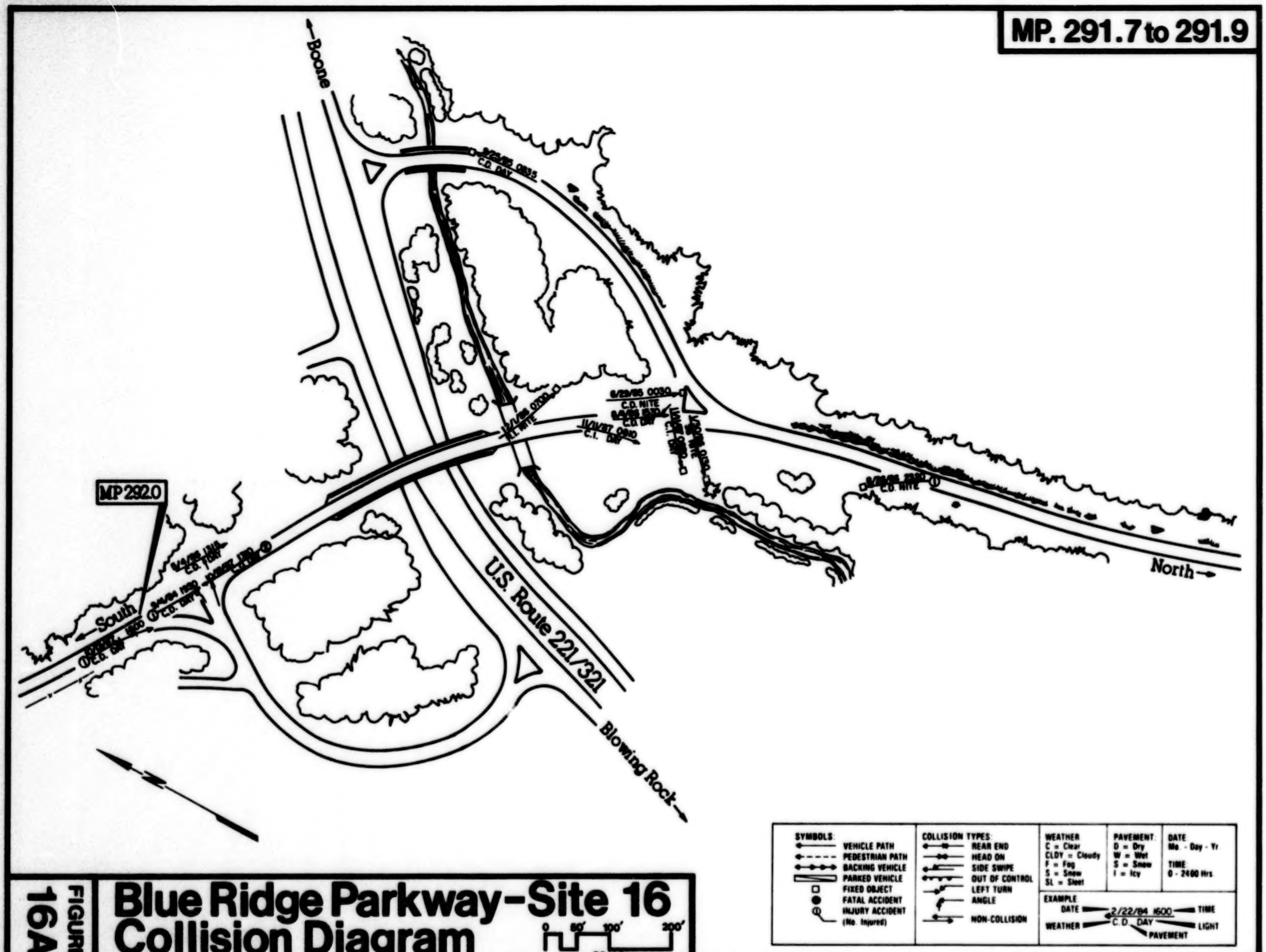


FIGURE 16A

Blue Ridge Parkway–Site 16 Collision Diagram

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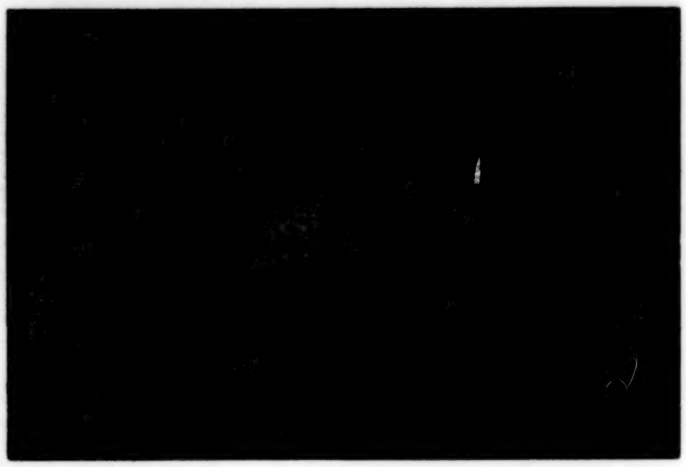
Site Photographs

Photograph 1: This photograph of the site presents the driver's view of the approach to the junction of the Parkway and the south ramp. Note that the terminal end of the guardrail is located adjacent to the exit ramp.

Photograph 2: White edgelines and steel guardrail have been used on the south ramp.

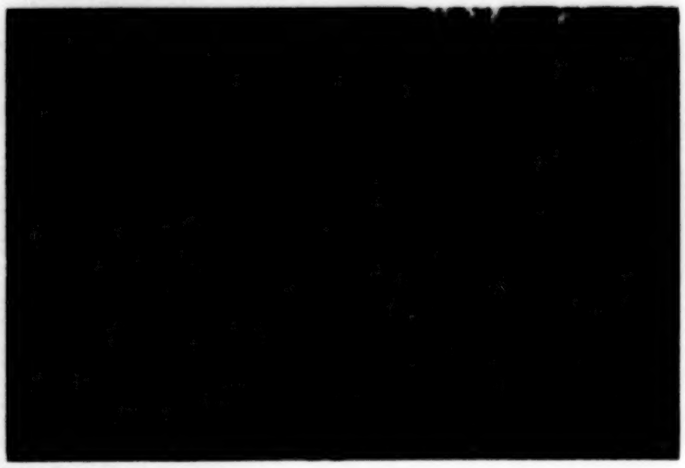
Photograph 3: This photograph shows the alignment change where the north ramp intersects U.S. 221/321.

Photograph 4: The stop sign on the north ramp is not visible to approaching traffic due to the trees along the right side of the road.



Photograph 1

Photograph 2



Photograph 3

Photograph 4

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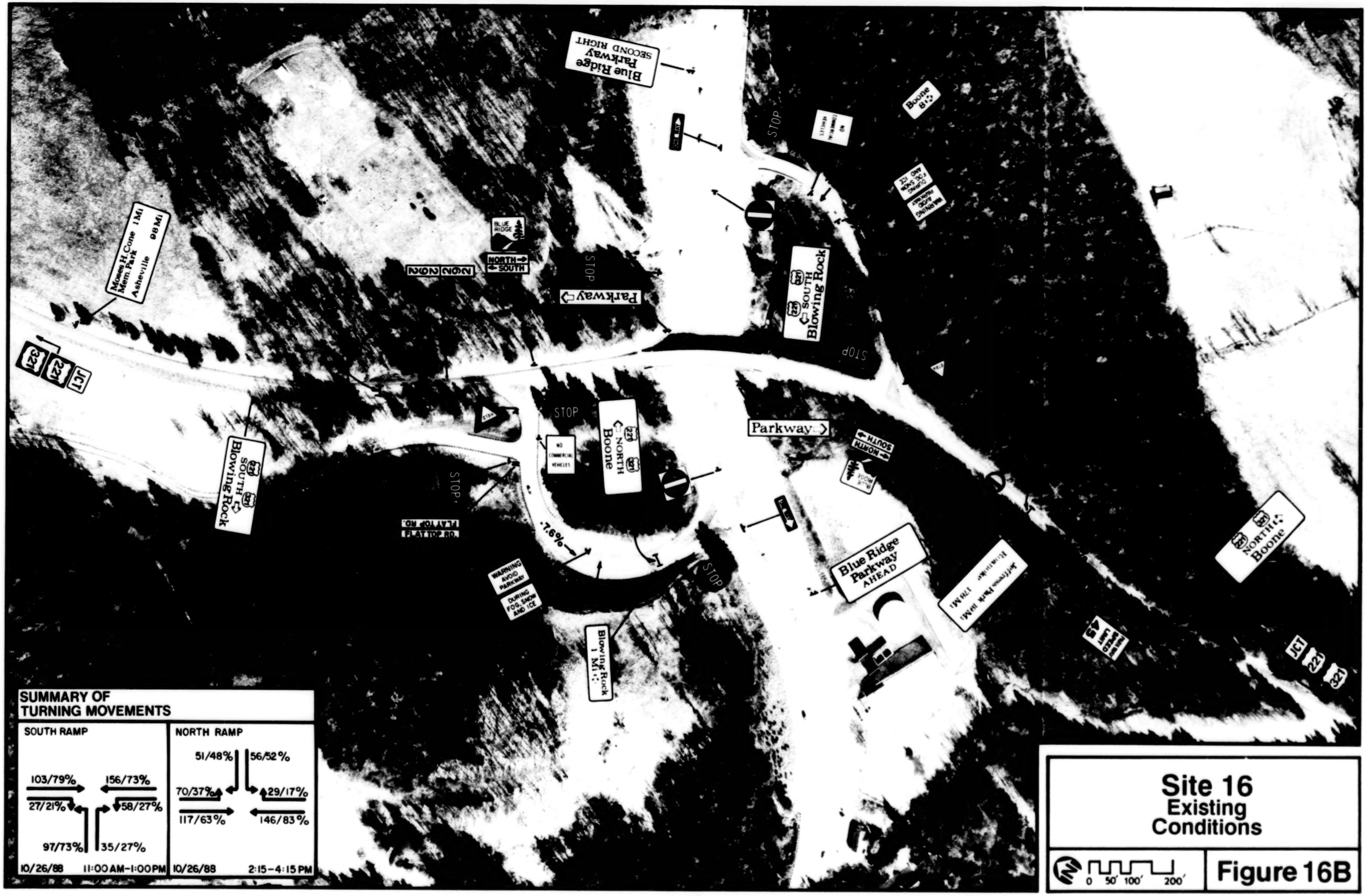
PAGE



SUMMARY OF TURNING MOVEMENTS

SOUTH RAMP	NORTH RAMP
103/79%	51/48%
156/73%	56/52%
27/21%	70/37%
58/27%	29/17%
97/73%	117/63%
35/27%	146/83%
10/26/88 11:00 AM-1:00 PM	10/26/88 2:15-4:15 PM

Site 16
Existing Conditions

Figure 16B

Recommended Improvements

The major problems at this interchange are located on the exit ramps and include deficient signing and sight distance limitations at both junctions with the Parkway. A vehicle conflict study performed on the Parkway indicated that 13% of the traffic at the north ramp and 16% of the traffic at the south ramp had difficulty negotiating the layout of each exit ramp.

The recommendations presented below address these deficiencies:

List of Improvements	Estimated Cost
● Install 20 mph advisory exit speed signs (W13-2, 24"x30") on both Parkway approaches to this interchange. Locate the signs approximately 250 feet from the exit.	$ 600.00
● Install 15 mph advisory exit speed signs (W13-2, 24"x30") on both approaches on U.S. 221/321. Locate the signs approximately 250 feet from the exit.	600.00
● Install U.S. route markers with directional arrows (M1-4 and M6-2) on the median islands at the Parkway junction as shown in Figure 16C.	1,000.00
● Install "Keep Right" signs (R4-7, 24"x30") on the median islands at the junctions with U.S. 221/321 as shown in Figure 16C.	600.00
● Install "Stop Ahead" signs (W3-1A, 30"x30") on both exit ramps approximately 300 feet in advance of each stop sign.	1,200.00
● Install painted stop bars adjacent to each stop sign.	800.00
● Install 4" white shoulder stripes on the north ramp. The south ramp already has shoulder striping.	750.00
● Remove the median curbing from all four median islands at this site.	8,000.00
● Remove the trees and shrubs that block the sight distance at the Parkway ramp junctions as shown in Figure 16C.	3,000.00
● Modify the end of the existing steel guard rail on the south ramp by warping the southernmost end away from the roadway. The existing guard rail end is located approximately 6 feet from the roadway shoulder at the entrance to the exit ramp.	2,000.00
● Replace the existing yield signs with standard size (36"x36"x36") yield signs.	600.00
Total Improvement Costs:	**$19,150.00**
Benefit/Cost Ratio:	**1.30**

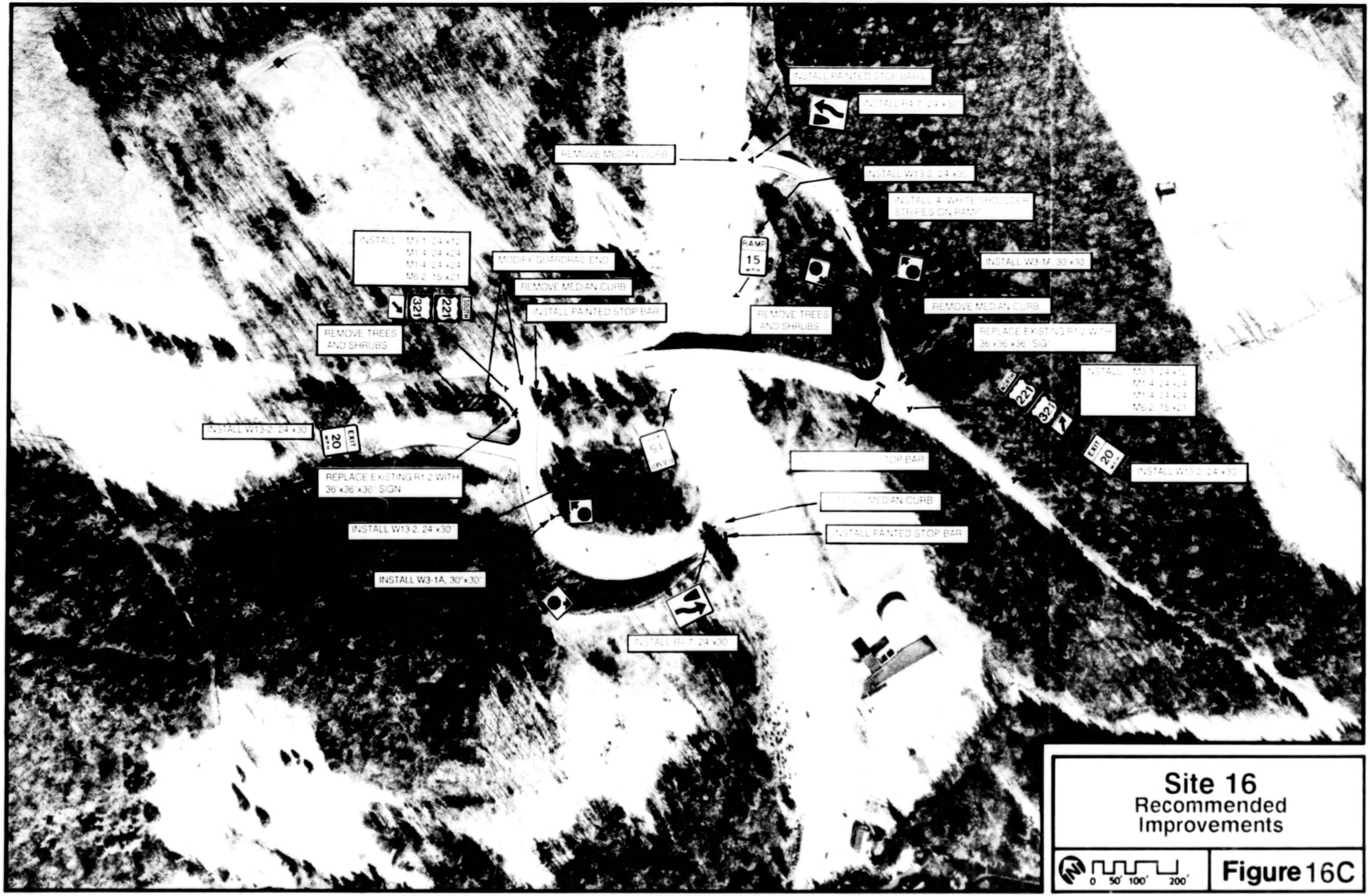
Hazard Index Calculation Form

Site 16: MP 291.7 - 291.9, Junction U.S. 221

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	3.0	acc/yr	44.0	x	0.164	=	7.22
Accident Rate	4.72	acc/MVE	64.0	x	0.225	=	14.40
Accident Severity	12,400	dollars	69.0	x	0.191	=	13.18
Sight Distance Ratio	.45	(wt. avg.)	100.0	x	0.074	=	7.40
Driver Expectancy	4.0	(wt. avg.)	66.7	x	0.149	=	9.94
Information System Deficiencies	3.33	(wt. avg.)	55.5	x	0.115	=	6.38

Hazard Index:	58.52
Cost of Recommended Improvements:	$19,150.00
Cost Factor:	90

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(58.52 x .75) + (90 x .25) = 66.39



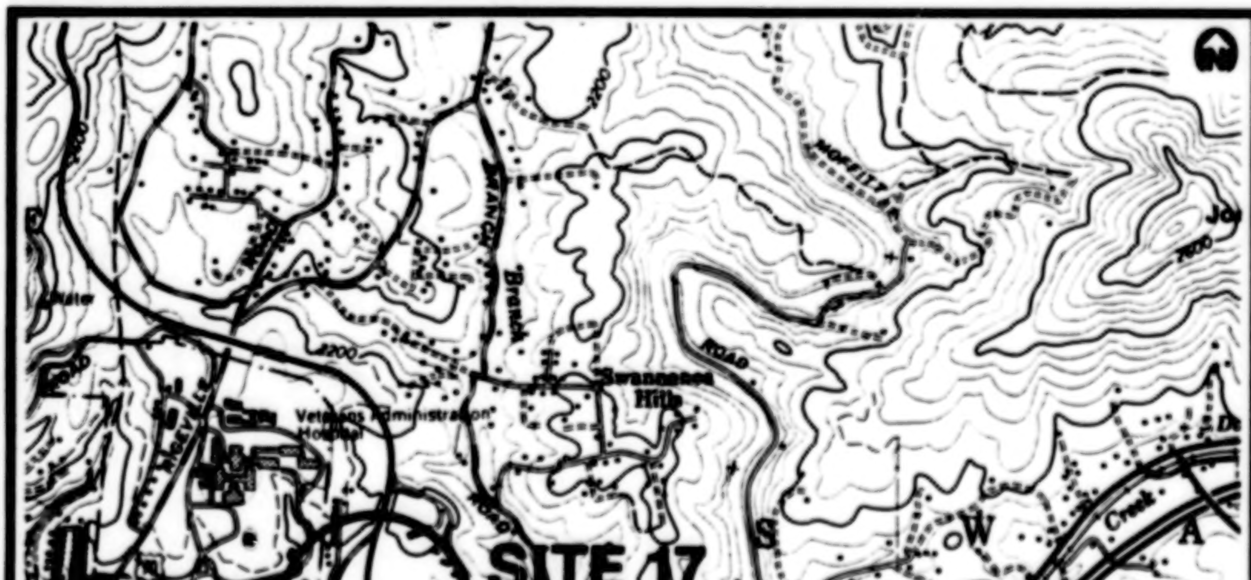
Site 16
Recommended Improvements

Figure 16C

SITE 17

Existing Conditions

This site is located at Parkway Milepost 382.0 on the outskirts of Asheville, North Carolina. Site 17 includes a two-quadrant interchange formed by the intersections of access ramps from the Parkway to U.S. Highway 70. An intersection with the access road to the NPS's Oteen Maintenance Area is located just south of Milepost 382.0. The location of the site is shown in the figure below. Grades on the Parkway are relatively flat at between 2 and 2.5%; however, the maximum grades of the north and south access ramps are quite steep at 13% and 14%, respectively. The centerline striping at this site prohibits passing on the Parkway and the access ramps. The width of the road surface of the Parkway and ramps is somewhat variable but averages between 22.0 and 23.0 feet. The road surfaces are in good condition. Right turn lanes have been provided on U.S. 70. All existing conditions at this site are presented in Figure 17B. A summary of the turning movement counts conducted at this location are also shown in the figure.



Site Location

Blue Ridge Parkway
MP 382.0 to 382.2

Accident History

The Parkway junction with U.S. 70 was the site of ten accidents during the four-year study period. Three of the accidents took place on or near the south exit ramp, one occurred on the bridge, and six happened on the north exit ramp. The location of each accident is shown in Figure 17A. The accidents included two rear-end collisions, one sideswipe, one angle accident, and six collisions with fixed objects. Median curbs were struck in four of the six fixed-object collisions. Three of the ten accidents produced a total of three injuries. Excessive speed and reckless driving were the primary causes of the accidents at this site. All ten accidents occurred when conditions were clear and dry. Seven of the accidents happened during the day. The composite characteristics of the ten accidents that occurred at this site are shown below.

ACCIDENT DATA

SITE 17: MP 382.0 - 382.2 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
2	1	2	5

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
1	2	2		3	2	

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			1		1	1	4		1	2	

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
							1					2	1		2	1	1	1				1	

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
7	1		2

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
10				

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
10			

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
1	2	6			1				

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
		5	4	1				

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)	1 (1)			2 (2)	3 (3)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.	1	1	2	3	7

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

1

MP. 382.0 to 382.2

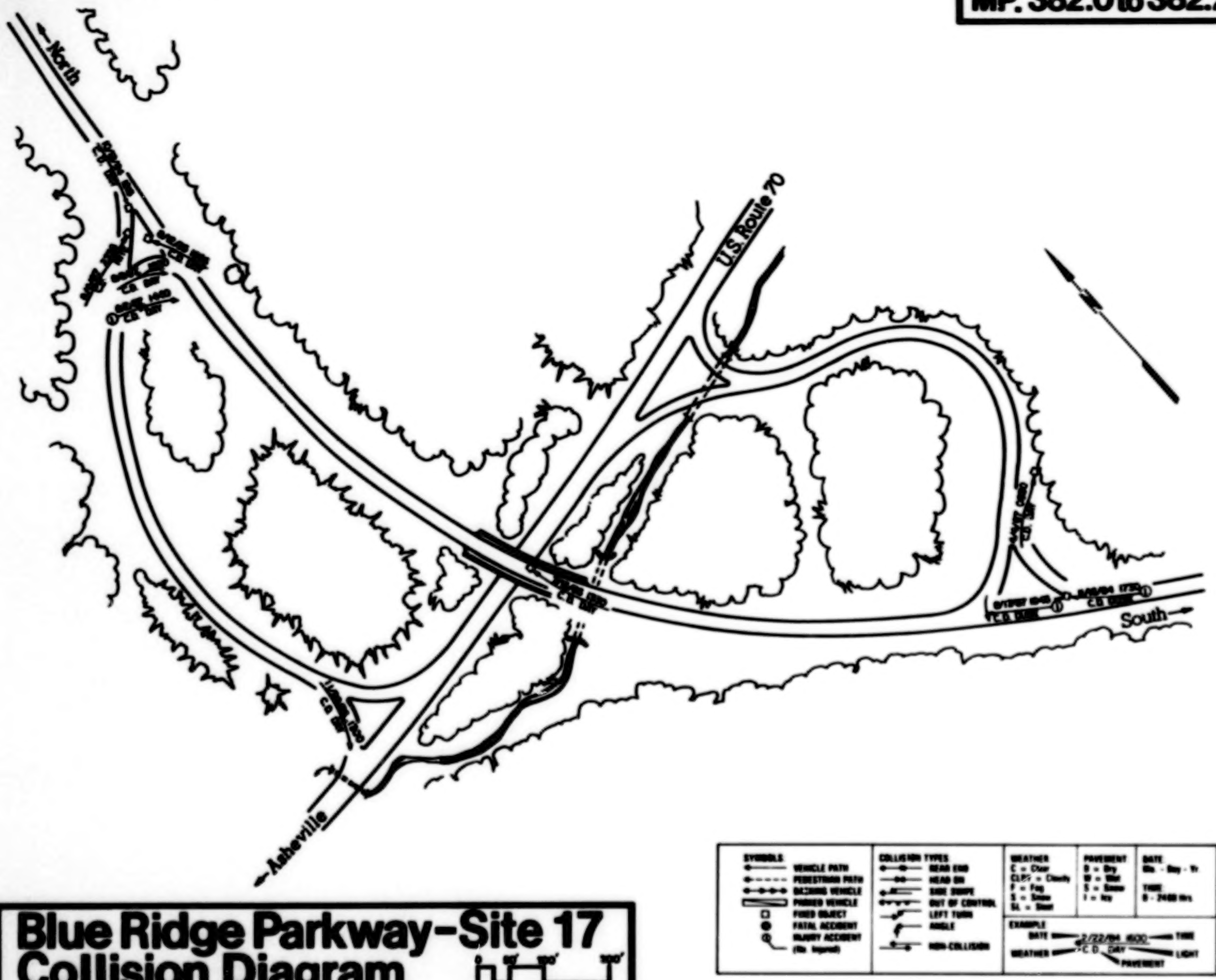


FIGURE 17A

Blue Ridge Parkway–Site 17 Collision Diagram

0 50' 100' 200'
SCALE

Site Photographs

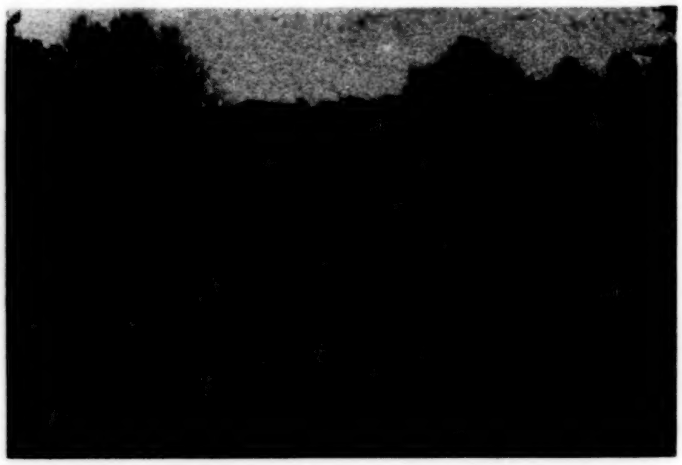
Photograph 1: Concrete paving blocks have been used to effectively counter shoulder wear at the north ramp's junction with the parkway. Note that the raised median at this intersection shows evidence of numerous collisions.

Photograph 2: There is no advisory speed posted for the north exit ramp. Tests indicated that 20 mph was the maximum safe speed for both ramps at this site.

Photograph 3: The back slope on the right side of the road blocks the view of the south ramp for approaching traffic.

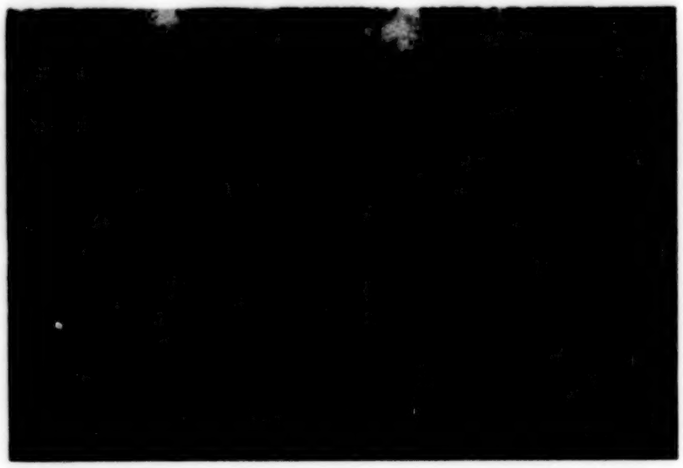
Photograph 4: The "Folk Art Center" sign on the south ramp blocks the view of the stop sign located at the Parkway.

Photograph 1



Photograph 2

Photograph 3



Photograph 4

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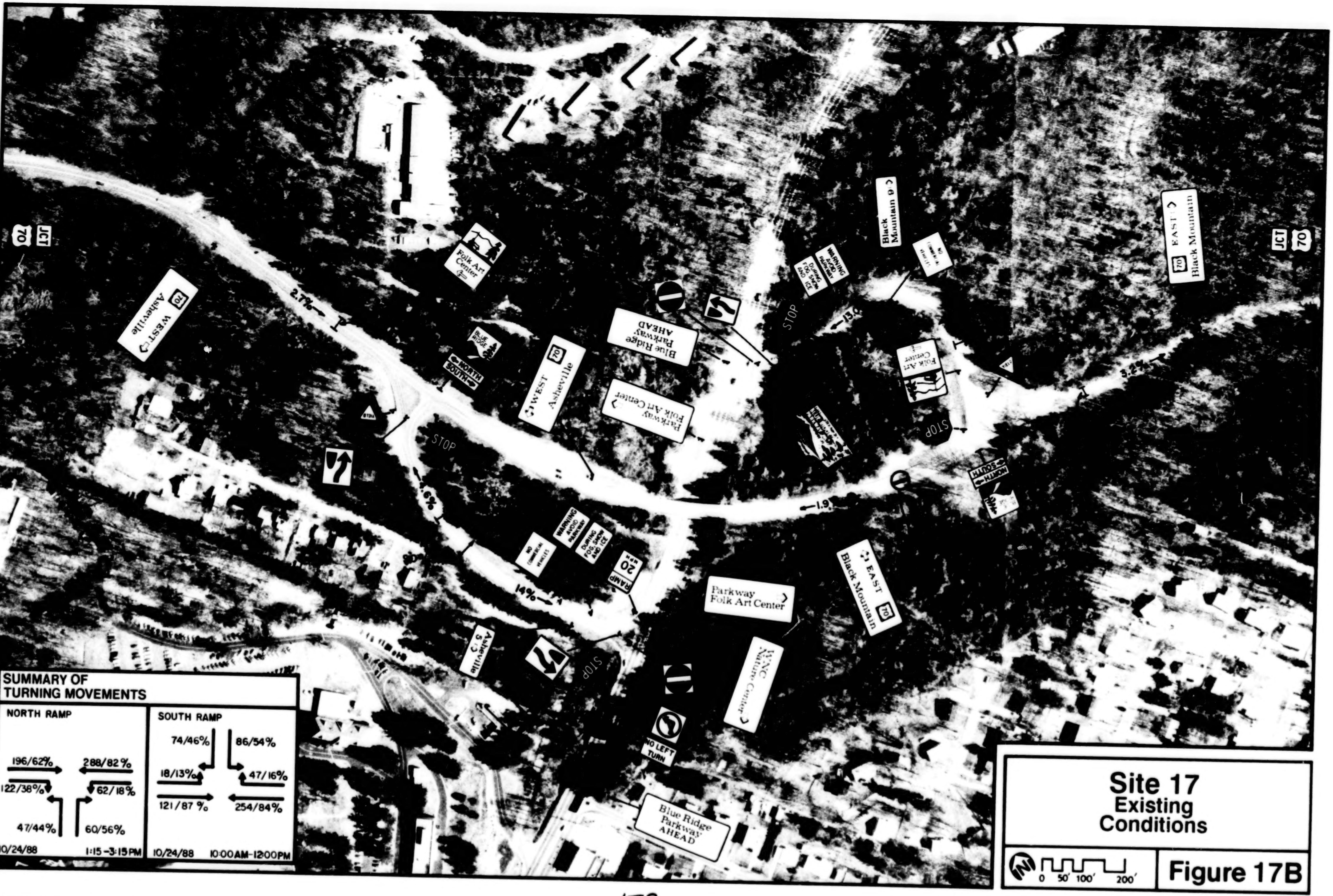

Site 17
Existing Conditions

Figure 17B

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Recommended Improvements

The major deficiencies at this interchange are located on the exit ramps. The maximum safe speed for both ramps was determined to be 20 mph while the average approach speed was determined to be 40 mph. The sight distance is limited by vegetation and the curvature of the exit ramp at several locations. The curbs at the medians evidence numerous vehicle strikes. These median curbs were involved in 40% of all accidents at this site during the study period. Vehicle conflicts or traffic violations were recorded for approximately 14% of the motorists passing through this site during a vehicle-conflict study. The most common vehicle conflict involved through traffic on the Parkway and vehicles turning at the ramps.

List of Improvements	Estimated Cost
● Install 20 mph advisory exit speed signs (W13-2, 24"x30") on both Parkway approaches to this interchange. Locate the signs 250 feet from each exit ramps.	$ 600.00
● Install U.S. route markers with directional arrows (M1-4 and M6-2) on the median islands as shown in Figure 17C.	800.00
● Install a 20 mph advisory exit speed sign (W13-2, 24"x30") on the west approach on U.S. 70. Locate the signs 250 feet from the beginning of the exit ramp.	300.00
● Install "Stop Ahead" warning signs (W3-1A, 30"x30") 300 feet back from each stop sign at this interchange.	1,200.00
● Install painted stop bars adjacent to all stop signs.	800.00
● Remove the curb on all of the median islands.	14,000.00
● Install 4" white shoulder stripes on both exit ramps.	1,500.00
● Remove the trees that limit sight distance at this interchange. The areas requiring tree removal are shown in Figure 17C.	4,000.00
● Replace the undersized yield signs (24"x24") located at the Parkway ramp junctions with standard 36"x36"x36" yield signs.	600.00
● Remove the "Keep Right" sign from the median at the north Parkway junction.	100.00
Total Improvement Costs:	**$24,200.00**
Benefit/Cost Ratio:	**1.03**

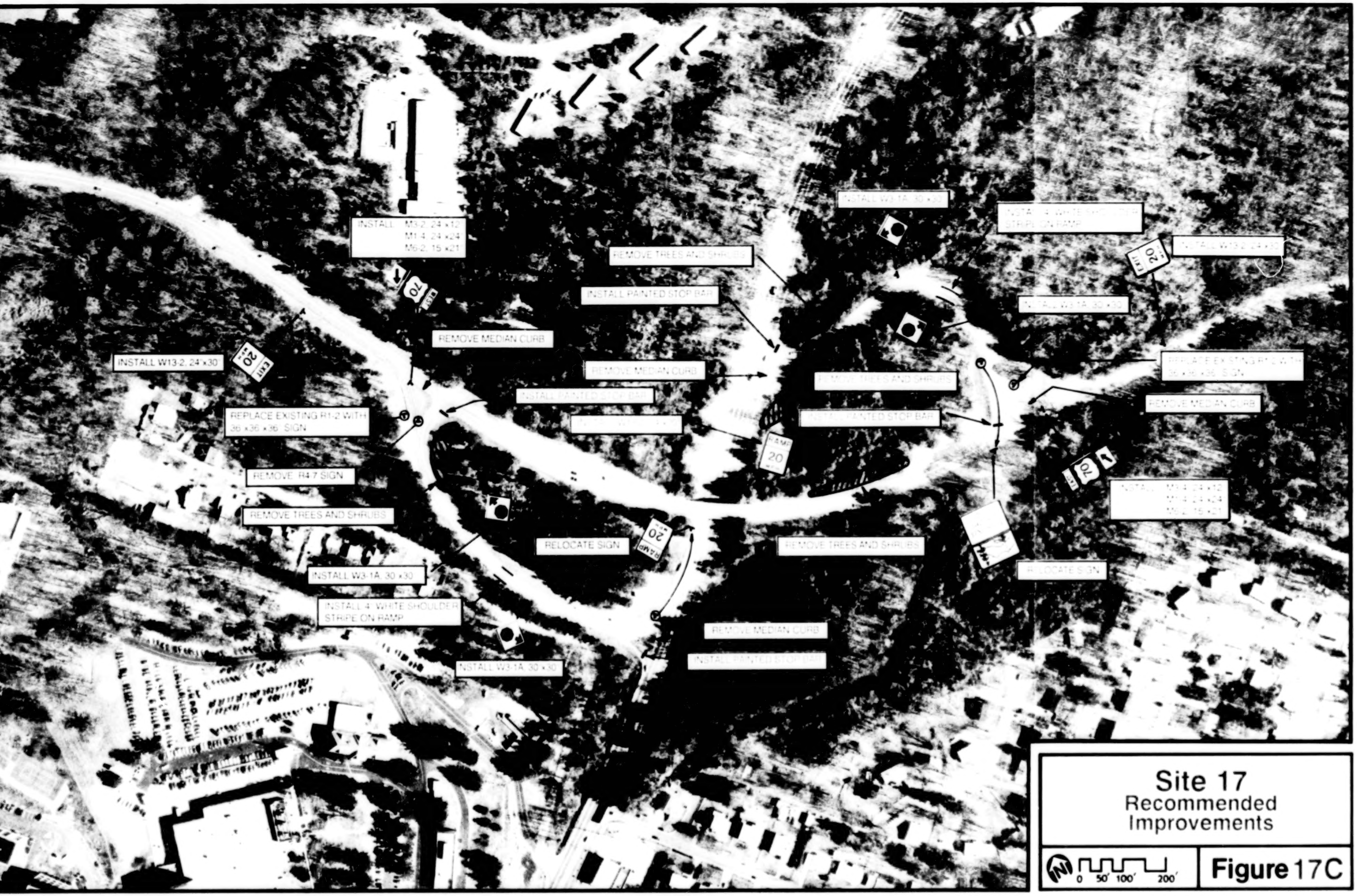
Hazard Index Calculation Form

Site 17: MP 382.0 - 382.2, Junction U.S. 70

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	2.5	acc/yr	40.0	x	0.164	=	6.56
Accident Rate	1.43	acc/MVE	24.0	x	0.225	=	5.40
Accident Severity	9,730	dollars	61.0	x	0.191	=	11.65
Sight Distance Ratio	.65	(wt. avg.)	75.0	x	0.074	=	5.55
Driver Expectancy	3.0	(wt. avg.)	50.0	x	0.149	=	7.45
Information System Deficiencies	3.0	(wt. avg.)	50.0	x	0.115	=	5.75

Hazard Index:	42.36
Cost of Recommended Improvements:	$24,200.00
Cost Factor:	96

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(42.36 x .75) + (96 x .25) = 55.77

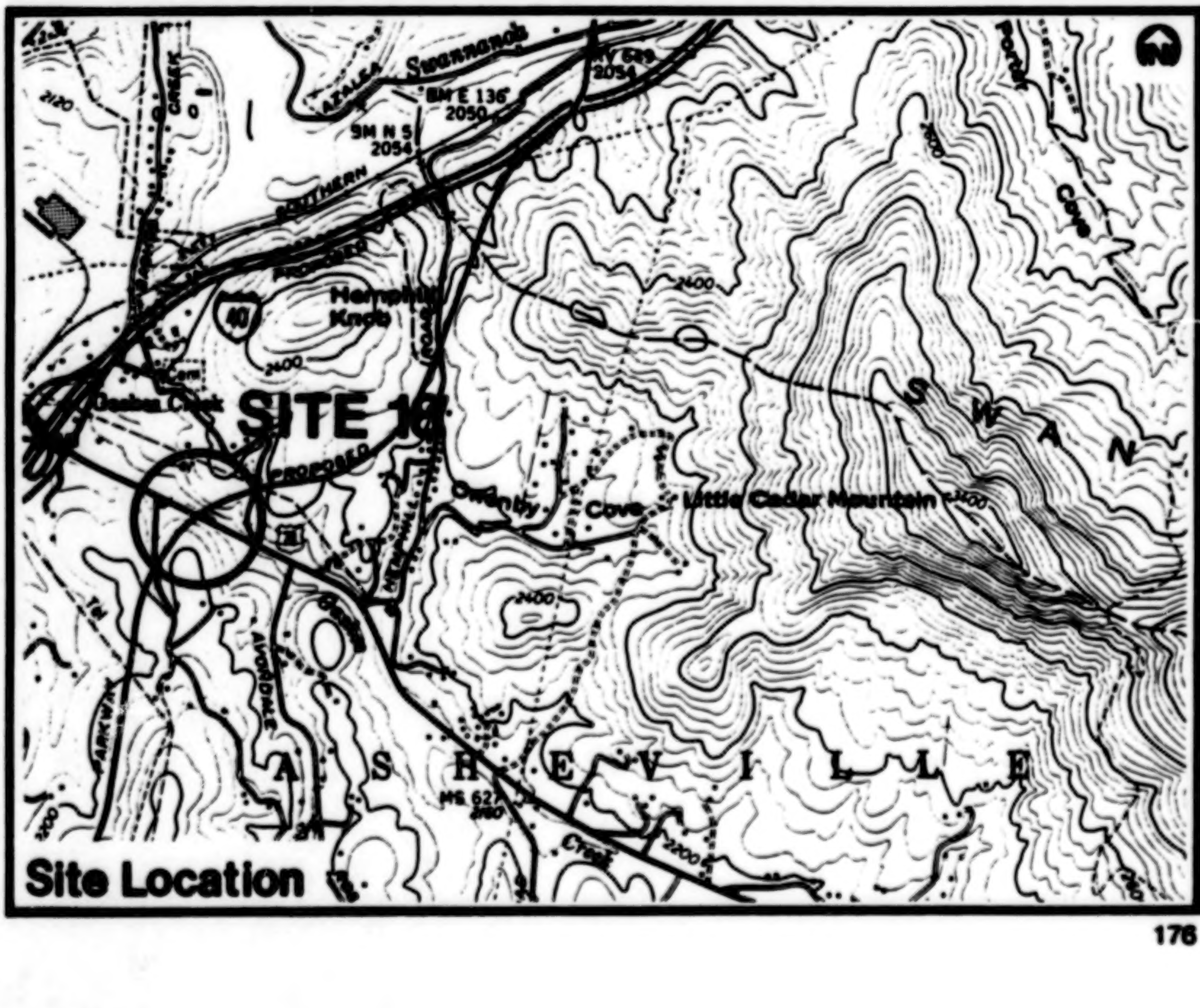


Site 17
Recommended Improvements

Figure 17C

SITE 18
Existing Conditions

This site consists of a two quadrant interchange which connects the Parkway with U.S. Highway 74. The site, located at Mileposts 384.6 to 384.8, is situated just east of Asheville, North Carolina. The site includes the access ramps and intersections that connect the Parkway to U.S. 74, an overpass, and the approaches to the access ramps on the Parkway. The grades on the Parkway were measured at 6.1% on the north approach and 13% on the south approach. Grades on the north and south ramps measured 5% and 12%, respectively. The road surfaces at this site are in good condition and average 21.0 feet in width. Centerline striping prohibits passing between the intersections on the Parkway and on the access ramps. Yield and stop signs are used to control traffic at the ramp junctions. Figure 18B shows all existing signing and summarizes turning movement counts that were conducted at the site.



Site Location

Blue Ridge Parkway
MP 384.6 to 384.8

Accident History

A total of thirty-six accidents took place at the Parkway's junction with U.S. 74. The majority of these accidents occurred where the exit ramps intersect the Parkway and in the curve on the north exit ramp. The location of all accidents is shown in Figure 18A. There were fourteen multi-vehicle accidents and twenty-two single vehicle accidents recorded at this site during the study period. Fifteen accidents involved collisions with fixed objects such as the guardrail on the north exit ramp or the median curb. Only three of the thirty-six accidents at Site 18 resulted in injuries. Twenty-six accidents took place during daylight hours when the weather was clear, and twenty-three occurred on dry pavement. Excessive speed was a contributing factor in more than half of all accidents at this site. All important characteristics for the accidents that occurred at Site 18 are compiled below.

ACCIDENT DATA

SITE 18: MP 384.6 - 384.8 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
2	14	8	12

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
5	3	7	6	4	8	3

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
4	2	2		1	4	3	7	5	2	5	1

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	1					4	1	1	1	3	1			6	4	4	4	2	1		2		

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
27	6		3

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
23	9	1	3	

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
26	7	2	1

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
4	6	15			3	7	1		

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
4		8	19	3			2	

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)	1 (2)	1 (1)		1 (1)	3
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.	1	13	8	11	33

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

3

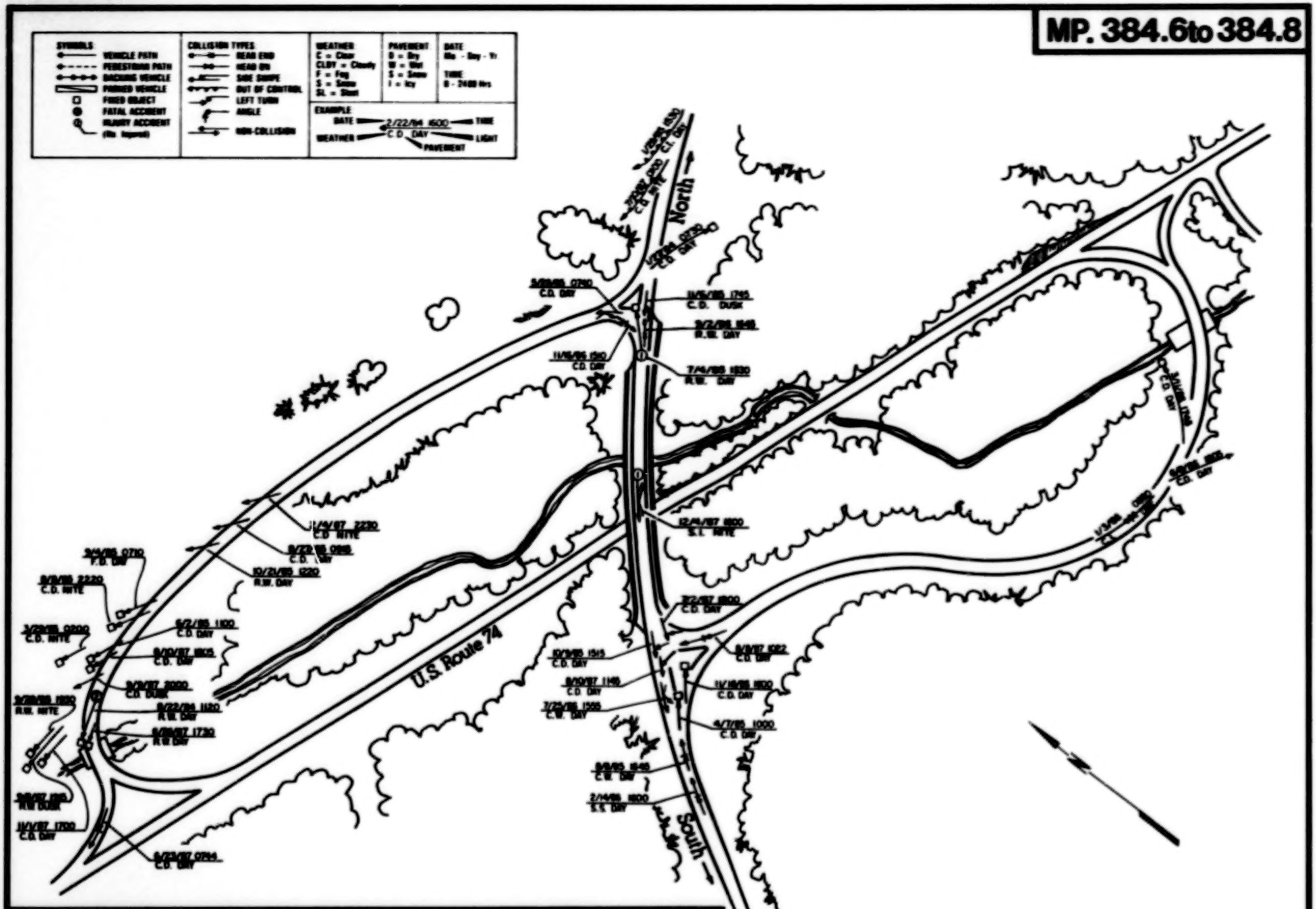


FIGURE 18A

Blue Ridge Parkway–Site 18 Collision Diagram

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Site Photographs

Photograph 1: This photograph of the north ramp shows that the back slope obstructs the view of the exit ramp for approaching traffic.

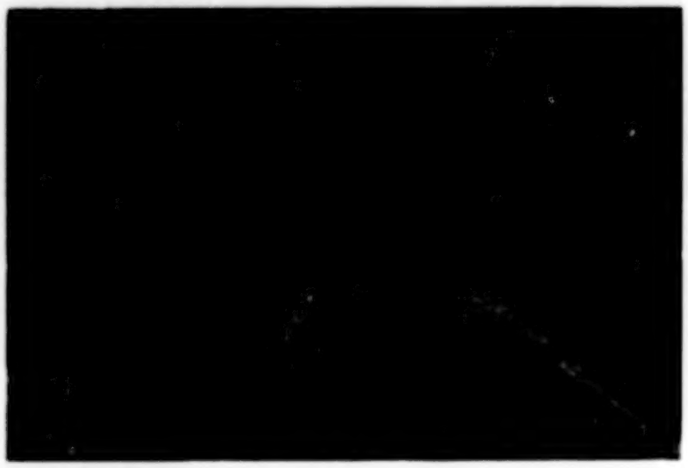
Photograph 2: Trees limit the view from the south ramp of Parkway motorists approaching the intersection.

Photograph 3: The large rocks placed on the median at the junction of the south ramp and U.S. 74 constitute fixed-object hazards and should be removed.

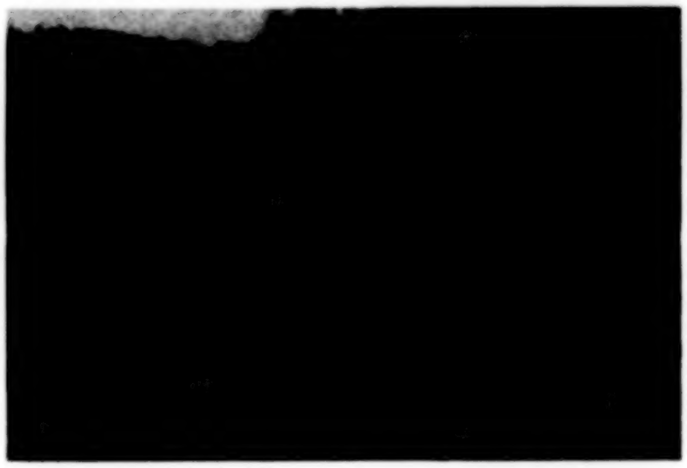
Photograph 4: Chevron warning signs were installed in the curve on the north ramp in 1988 by the NPS. No accidents have been reported at this location since the installation of the signs.

Photograph 1

Photograph 2



Photograph 3



Photograph 4

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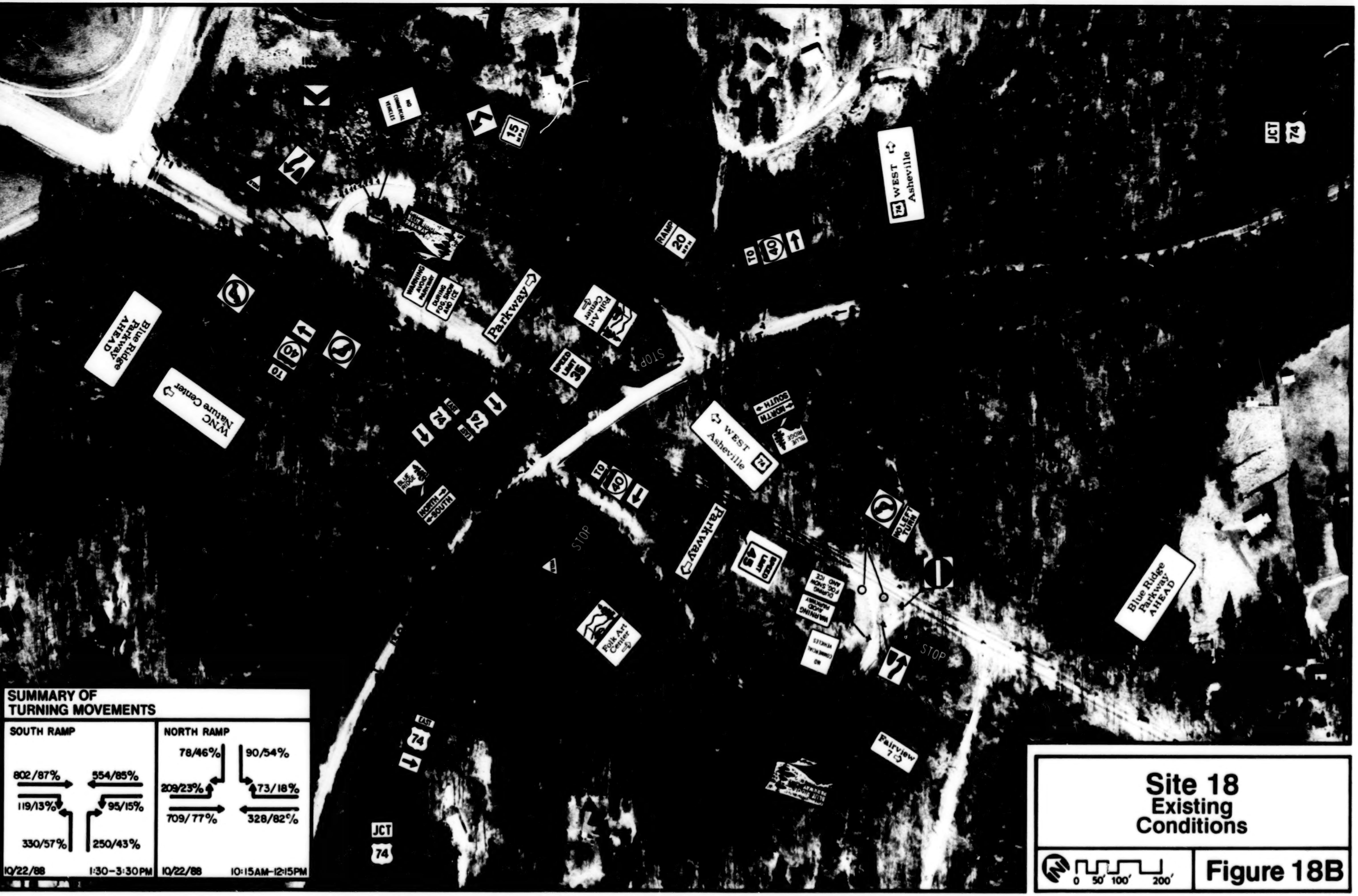


Site 18 Existing Conditions

Figure 18B

Recommended Improvements

Fourteen of the thirty-six accidents during the study period occurred in the curve on the north ramp. NPS installed eight chevron signs in this curve in 1988 to address this problem. No accident has been reported at this location since the installation of the signs.

There is a need for better identification of the Parkway junctions through appropriate exit ramp signing. The average approach vehicle speed was determined to be 45 mph while the maximum safe speed for the exit ramps is 20 mph. A vehicle conflict study performed at the site indicated that 22% of all approach vehicles at the north ramp and 12% at the south ramp produced vehicle conflicts or traffic violations. The majority of the traffic conflicts involved through traffic and vehicles entering or exiting the Parkway.

The following recommendations address the safety problems and deficiencies at this site:

List of Improvements	Estimated Cost
• Remove the existing 20 mph advisory exit speed sign located on the north ramp.	$ 100.00
• Install 20 mph advisory exit speed signs (W13-2, 24"x30") on the ramp approaches (both on the Parkway and on U.S. 74). Locate the signs 250 feet in advance of each ramp.	1,200.00
• Install U.S. route markers with directional arrows (M1-4 and M6-2) on the medians as shown in Figure 18C.	800.00
• Install painted stop bars adjacent to each stop sign at this site.	600.00
• Install "Stop Ahead" warning signs (W3-1A, 30"x30") 300 feet in advance of each stop sign.	900.00
• Install 4" white shoulder stripes on both ramps.	1,500.00
• Remove the boulders located in the vicinity of the south ramp junction with U.S. 74.	1,000.00
• Install a "No Left Turn" sign (R3-1, 24"x24") on the median at the south ramp junction with U.S. 74.	300.00
• Replace the undersized yield sign located at the south ramp junction with the Parkway with a standard size (36"x36"x36") yield sign. Install it on the right side of the ramp as shown in Figure 18C.	600.00
• Relocate the "Folk Art Center" signs to the positions shown in Figure 18C.	600.00
• Relocate the stop signs at the Parkway ramp junctions to make them more visible.	600.00
• Remove the trees that obstruct the view of the road alignment on the south ramp.	2,000.00

List of Improvements	Estimated Cost
• Remove the curbs from the median islands at this interchange.	16,000.00
• Flatten the back slope that blocks the view of the north ramp from the north approach.	10,000.00
• Remove the East 74 route marker and directional arrow (facing the northbound traffic) located across from the south ramp junction on the Parkway.	100.00
• Relocate the Interstate route marker from the north approach to a position approximately 350 feet north of the exit ramp.	300.00
Total Improvement Costs:	**$36,600.00**
Benefit/Cost Ratio:	**1.05**

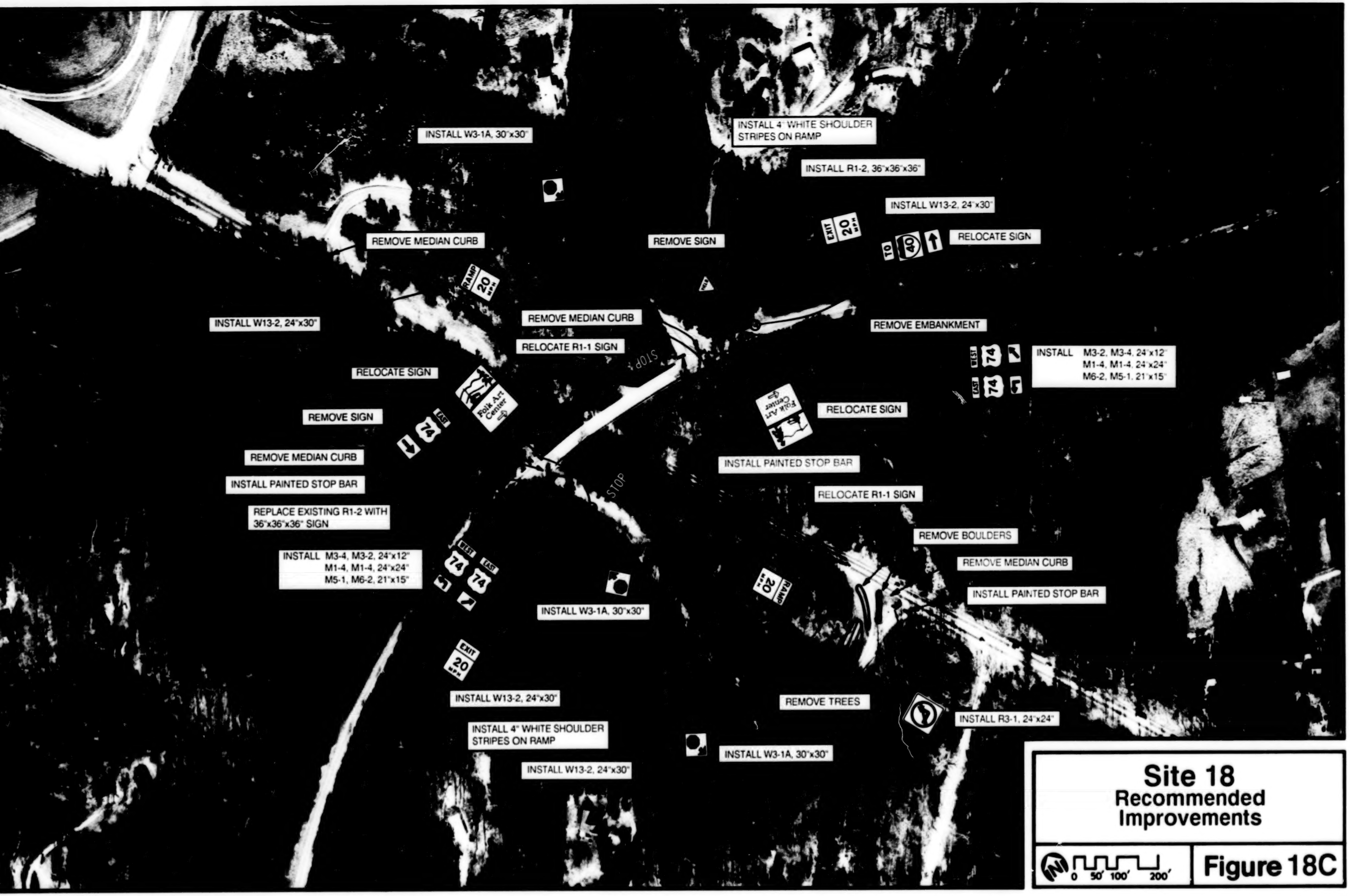
Hazard Index Calculation Form

Site 18: MP 384.6 - 384.8, Junction U.S. 74

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	9	acc/yr	73.0	x	0.164	=	11.97
Accident Rate	4.75	acc/MVE	64.0	x	0.225	=	14.40
Accident Severity	9,981	dollars	62.0	x	0.191	=	11.84
Sight Distance Ratio	.40	(wt. avg.)	100.0	x	0.074	=	7.40
Driver Expectancy	5.17	(wt. avg.)	86.2	x	0.149	=	12.84
Information System Deficiencies	5.5	(wt. avg.)	91.7	x	0.115	=	10.55

Hazard Index:	69.00
Cost of Recommended Improvements:	$36,600.00
Cost Factor:	94

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(69.00 x .75) + (94 x .25) = 75.25



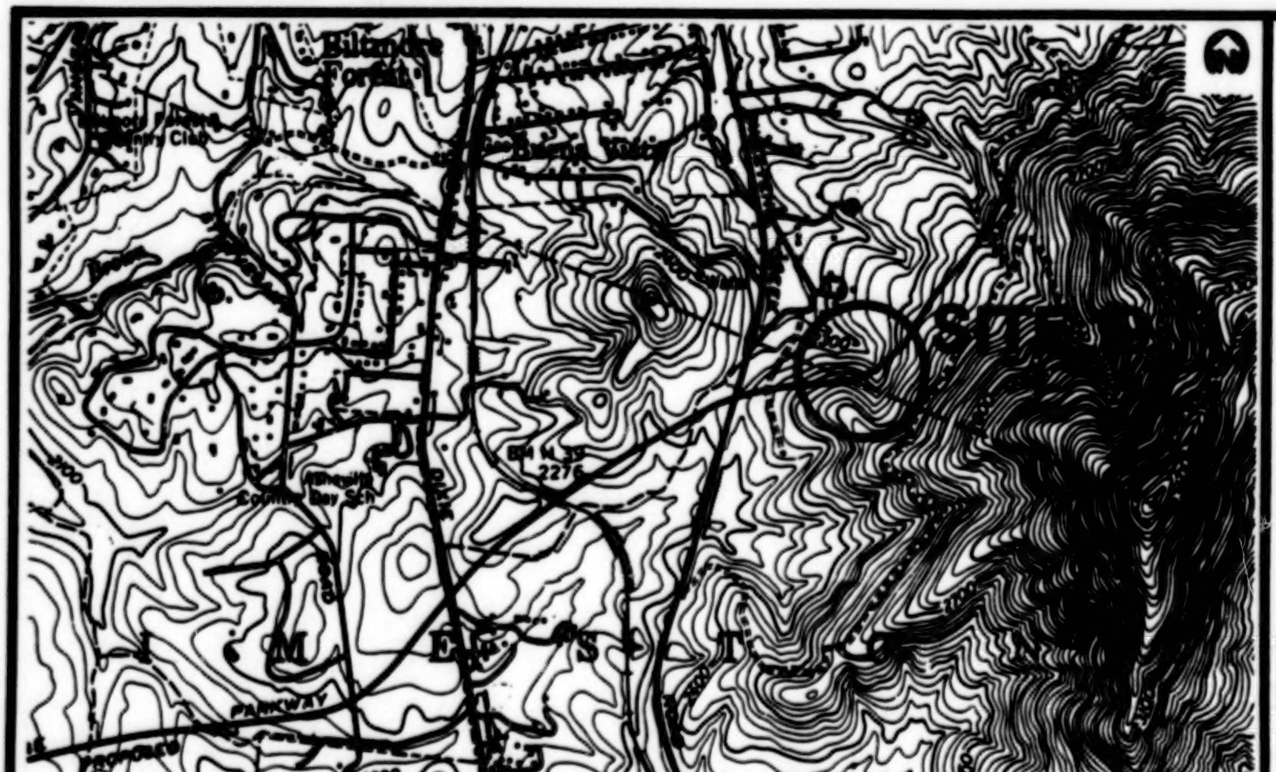
Site 18
Recommended Improvements

Figure 18C

SITE 19

Existing Conditions

Site 19 consists of a single curve located near Parkway Milepost 388.0 southeast of Asheville, North Carolina. The location of this site is shown in the figure below. The grade of the Parkway varies from 3.4 to 5.6% within the site. The road surface is typically 21.5 feet wide and is in good condition. The entire site has been striped with a double solid yellow centerline. Other than striping, the only traffic control devices at this site are seasonal warning signs ("Beware of Sudden Icing") equipped with amber flashing lights to emphasize the sign's message. All existing conditions at this location are shown in Figure 19B. The current traffic volume at Site 19 is estimated to be 4,500 vehicles per day. This section of the Parkway is used by Asheville commuter traffic.



Site Location

Blue Ridge Parkway
MP 387.8 to 388.0

Accident History

This location was the site of eighteen accidents during the four-year study period. The locations of these accidents are shown in Figure 19A. Fourteen of the accidents occurred during the months of January and February and were the result of icy-road conditions. Southbound motorists often lost control during such road conditions and sideswiped other vehicles or left the road and struck fixed objects. There were eight sideswipes and eight fixed-object accidents reported at the site during the study period. Vehicles rolled in four of the run-off-the-road accidents. Only four accidents resulted in injuries. Sixteen accidents happened when the weather was clear, and thirteen took place at night or low-light conditions. The composite characteristics of the eighteen accidents at this site are presented below.

ACCIDENT DATA

SITE 19: MP 387.8 - 388.0 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
7	2	2	7

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
	1	7	1	2	3	4

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
6	8			2	1	1					

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1		1		3	4			9						1	2	2					1		1

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
6	10	1	1

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
4			14	

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
16	1	1	

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
		8			8	2			

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
12		4	2					

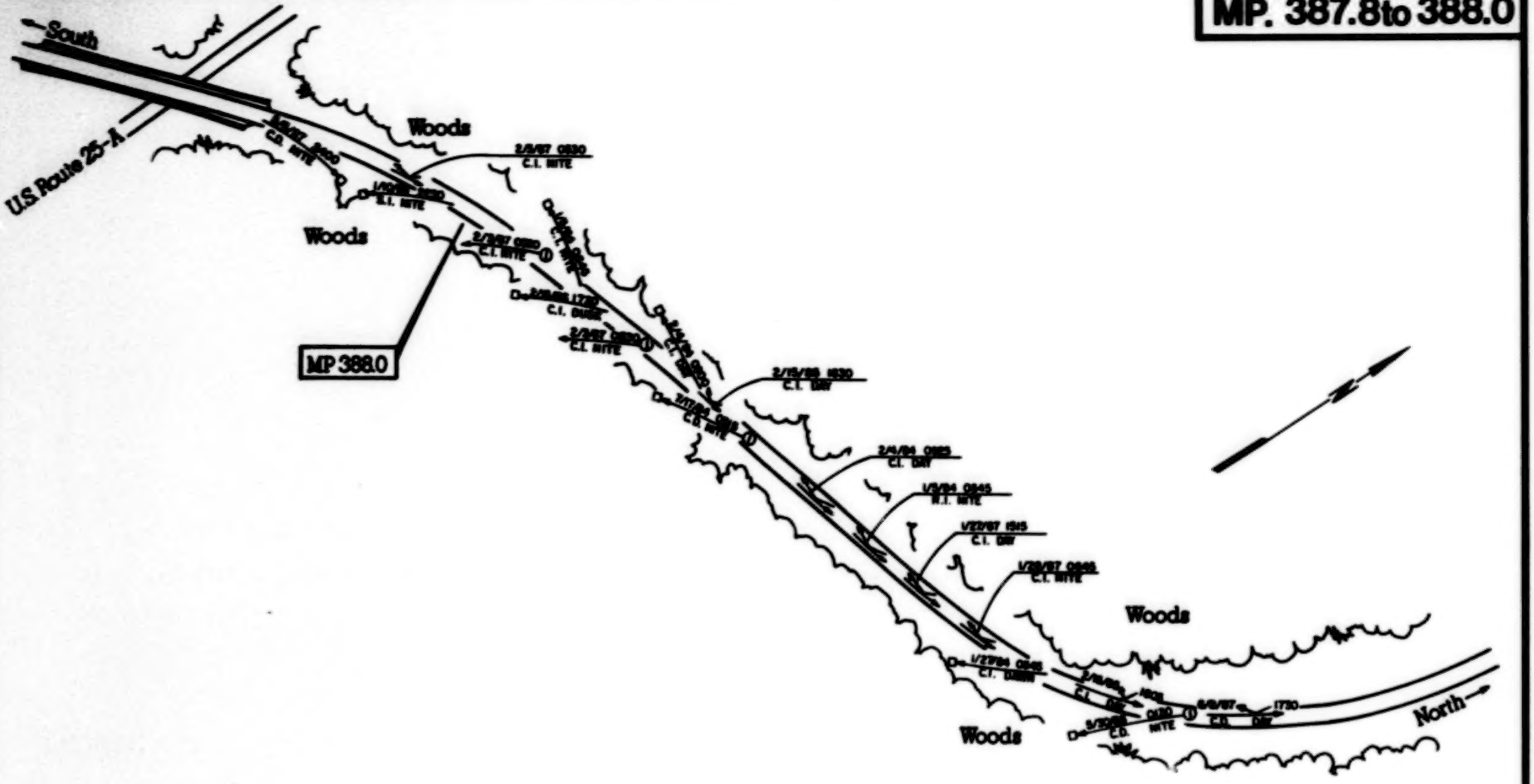
NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)	1 (1)		1 (1)	2 (2)	4 (4)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.	6	2	1	5	14

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

0

MP. 387.8to 388.0



SYMBOLS:
VEHICLE PATH
PEDESTRIAN PATH
BACKING VEHICLE
PARKED VEHICLE
☐ FIXED OBJECT
● FATAL ACCIDENT
① INJURY ACCIDENT (No. Injured)

COLLISION TYPES:
REAR END
HEAD ON
SIDE SWIPE
OUT OF CONTROL
LEFT TURN
ANGLE
NON-COLLISION

WEATHER
C = Clear
CLDY = Cloudy
F = Fog
S = Snow
SL = Sleet

PAVEMENT
D = Dry
W = Wet
S = Snow
I = Icy

DATE
Mo. - Day - Yr

TIME
0 - 2400 Hrs.

EXAMPLE
DATE 2/22/84 1600 TIME
WEATHER C.D. DAY LIGHT
PAVEMENT

FIGURE 19A

Blue Ridge Parkway-Site 19 Collision Diagram

0 50' 100' 200'
SCALE

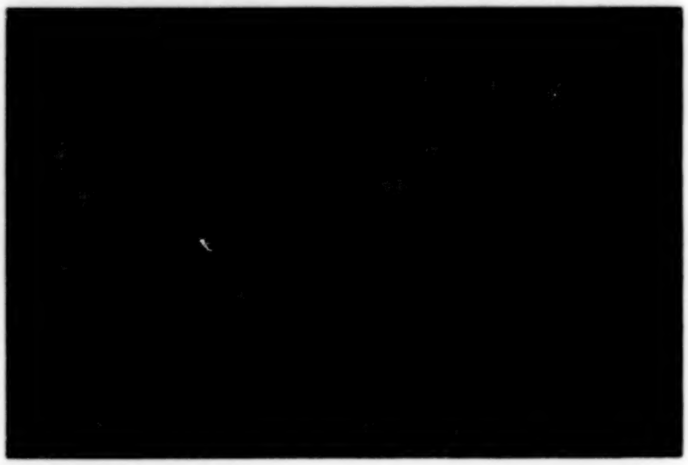
Site Photographs

Photograph 1: This photograph shows the site from the north approach. The hinged warning sign located on the right side of the road must be manually turned to face traffic during icy-road conditions.

Photograph 2: This "Beware of Sudden Icing" warning sign has a steel box which protects the amber, flashing light mounted on the top of the sign post.

Photograph 3: The box-shaped drainage channel located along the west side of the Parkway presents a significant hazard to errant vehicles. A flatter "V" ditch is more desirable in this location.

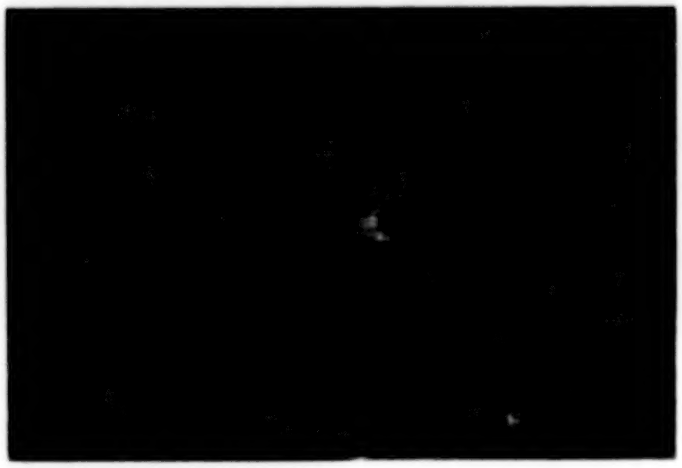
Photograph 4: This view looking north from MP 388 shows the gentle roadway alignment of the Parkway at this site.



Photograph 1

Photograph 2

Photograph 3



Photograph 4

Recommended Improvements

The accident history of this road section is almost entirely the result of icy-road conditions. The mountainous terrain to the southeast shades the roadway during the winter months resulting in frequent icy conditions. The severity of ice-related accidents at this site is often compounded by the presence of commuter traffic. Heavier traffic volumes have resulted in more multi-vehicle accidents than in other locations in the Parkway. The shape of the drainage ditch along the roadside tends to increase the severity of run-off-the-road accidents at this site. The drainage ditch should be modified to minimize the possibility of a roll-over or a fixed-object collision during run-off-the-road accidents.

The following recommendations address the problems at this site:

List of Improvements	Estimated Cost
● Remove the box-shaped concrete drainage ditch located on the east side of the Parkway at this site. The shape of this ditch may cause an errant vehicle to stop abruptly or roll-over.	$10,000.00
● Fill the low area on the outside of the curve at MP 387.9.	5,000.00
● Install a "Beware of Sudden Icing" sign (36"x36") on both approaches and locate it 300 feet in advance of the existing signs as shown in Figure 19B. Remove these signs during the summer months.	800.00
● Remove the existing "Beware of Sudden Icing" signs at this location and install hinged "Ice on Pavement" warning signs (36"x36") with existing amber flashing lights at the same locations. Remove these signs during the summer months.	1,200.00
● NPS should consider the use of a high friction chip and seal application on this section of the Parkway to minimize the effects of the road icing. Surveillance and sanding of this road section during the winter should be a high priority. (No Cost Provided.)	
Total Improvement Costs:	**$17,000.00**
Benefit/Cost Ratio:	**1.05**

- Long-Term Improvement: Relocate the Parkway's alignment to the northwest (away from the mountain) to expose the road to the sun during the winter. Grade the shoulder areas as flat and smooth as possible to help minimize vehicle roll-overs.

Hazard Index Calculation Form

Site 19: MP 387.8 - 388.0

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	4.5	acc/yr	56.0	x	0.164	=	9.18
Accident Rate	3.28	acc/MVE	50.0	x	0.225	=	11.25
Accident Severity	14,544	dollars	73.0	x	0.191	=	13.94
Sight Distance Ratio	1.21	(wt. avg.)	22.0	x	0.074	=	1.63
Driver Expectancy	2.67	(wt. avg.)	44.5	x	0.149	=	6.63
Information System Deficiencies	2.5	(wt. avg.)	41.7	x	0.115	=	4.80

Hazard Index:	47.43
Cost of Recommended Improvements:	$17,000.00
Cost Factor:	98

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(47.43 x .75) + (98 x .25) = 60.07

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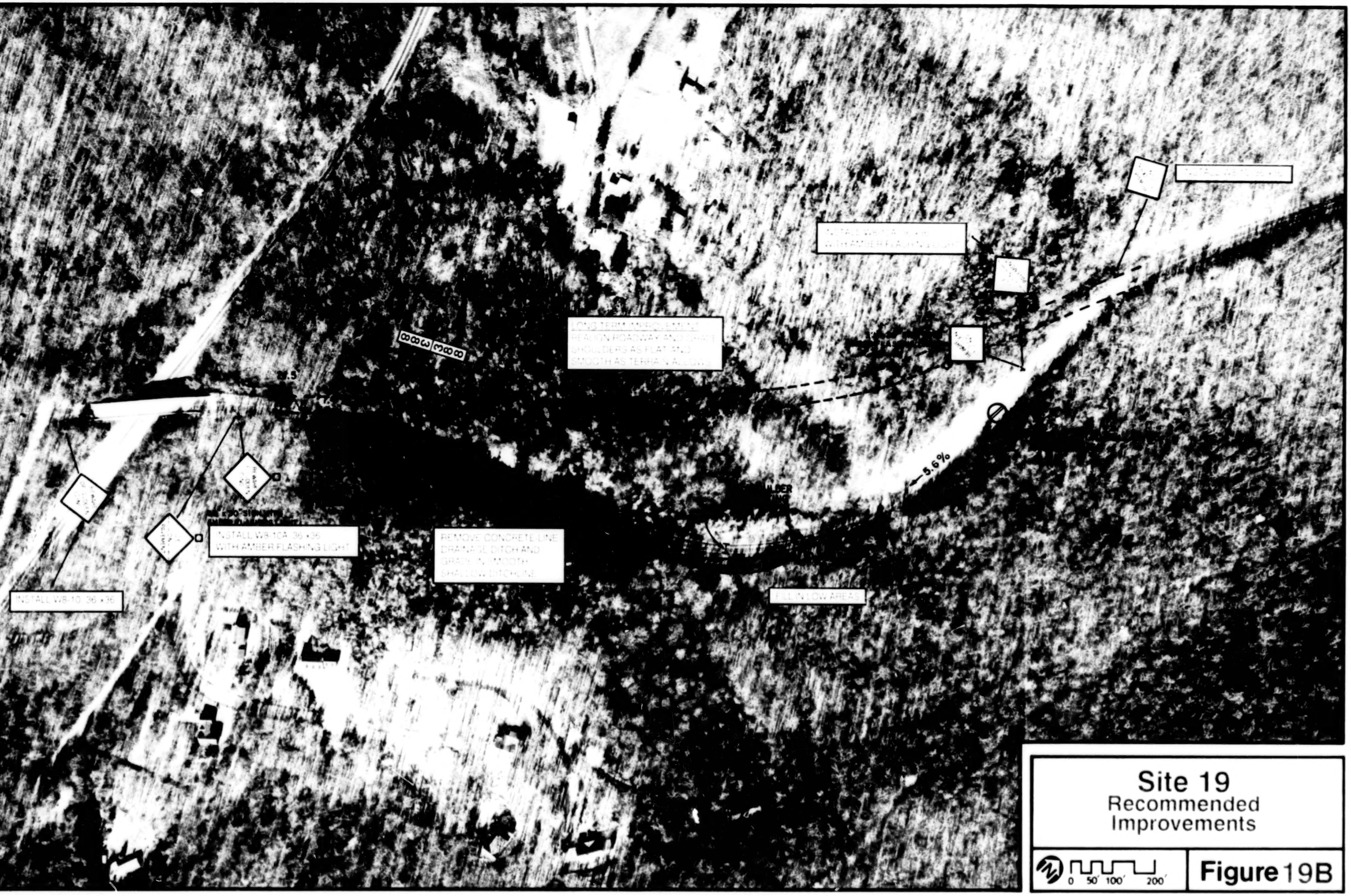

LONG TERM IMPROVEMENT
REALIGN ROADWAY AND GRADE SHOULDERS AS FLAT AND SMOOTH AS TERRAIN ALLOWS
INSTALL W8-1?A ... WITH AMBER FLASHING LIGHT
5.6%
INSTALL W8-10A 36 × 36 WITH AMBER FLASHING LIGHT
INSTALL W8-10 36 × 36
REMOVE CONCRETE-LINE DRAINAGE DITCH AND GRADE IN SMOOTH SHALLOW DITCHLINE
FILL IN LOW AREAS
0
50′
100′
200′

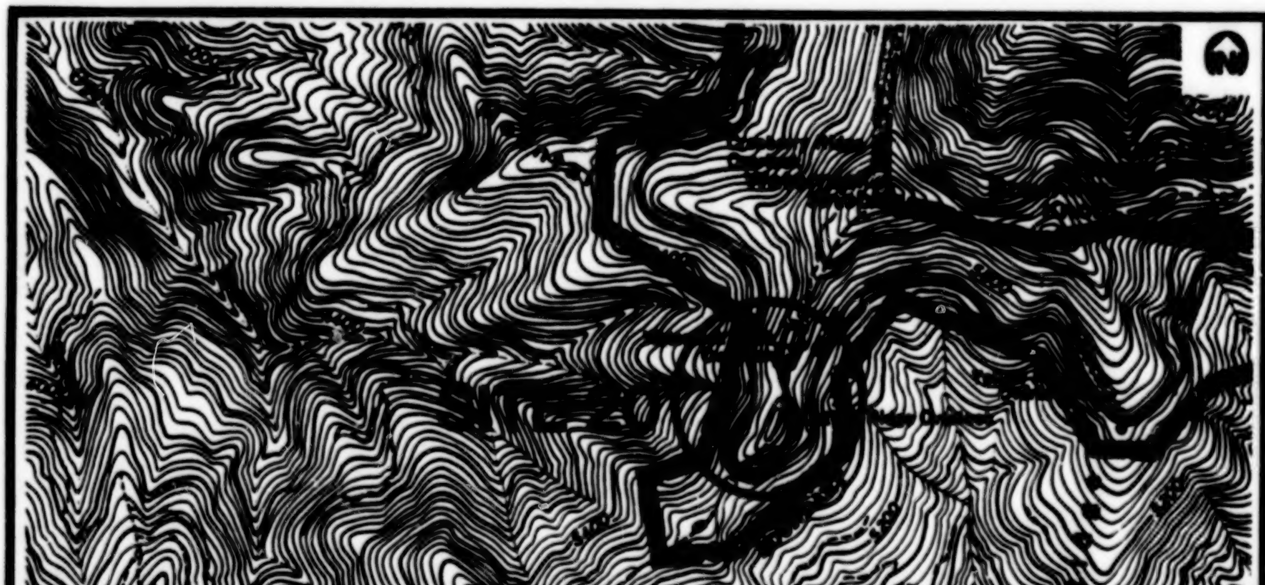
Site 19
Recommended
Improvements

Figure 19B

SITE 20

Existing Conditions

This site consists of a "T" intersection formed by the junction of the Parkway with the access road to Waterrock Knob Overlook near Milepost 451.0. The location of the site is shown on the map at the bottom of the page. The "T" intersection is located in the midst of a 180 degree curve in the Parkway. A turf median has been installed on the north and south approaches to the intersection to separate traffic flows. Grades on the Parkway range from 5.4 to 6.1% in the vicinity of the intersection. The access road to the overlook has a grade of 4.4%. Roadway widths are typically 21.0 feet on the undivided approaches and 20.0 feet on the road to the overlook. The Parkway's width (including the turf median) is 66 feet at the intersection. Figure 20B presents the existing conditions and summarizes the results of a turning movement count at this site.



Blue Ridge Parkway
MP 451.0 to 451.2

Accident History

A total of six accidents occurred at this site during the study period. The location of each accident is shown in Figure 20A. Four accidents happened at the intersection to Waterrock Knob Overlook and two others took place in the parking area for the attraction. Two collisions with a guiderail, one angle collision, and a non-collislion accident were recorded in the intersection. Accidents in the parking area included an angle collision and a fixed-object collision by a backing vehicle. Three of the four accidents at the intersection produced injuries to four persons. All six accidents at this site occurred during the day when conditions were clear and dry. Pertinent characteristics for the six accidents that occurred at Site 20 are summarized below.

ACCIDENT DATA

SITE 20: MP 451.0 - 451.2 **ACCIDENT PERIOD** 1984 - 1987

NO. OF ACCIDENTS BY YEAR

1984	1985	1986	1987
	1	3	2

NO. OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
1	2				2	1

NO. OF ACCIDENTS BY MONTH

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
					2	2	1	1			

NO. OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
									1		1	3	1										

NO. OF ACCIDENTS BY LIGHT CONDITIONS

Daylight	Dark	Dawn	Dusk
6			

NO. OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
6				

NO. OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
6			

NO. OF ACCIDENTS BY ACCIDENT TYPE

Angle	Rear End	Fixed. Obj.	Ped./Bike	Animal	Sideswipe	Non-Col.	Head-on	Backing	Other
2		2				1		1	

NO. OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Alcohol/ Drugs	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
		2	1	2		1		

NO. OF ACCIDENTS BY SEVERITY

	1984	1985	1986	1987	Total
Injury Acc. (No. of Injuries)		1 (1)	1 (2)	1 (1)	3 (4)
Fatality Acc. (No. of Deaths)					0
Property Damage Only Acc.			2	1	3

NO. OF ACCIDENTS INVOLVING MOTORCYCLES

2

MP. 451.0 to 451.2

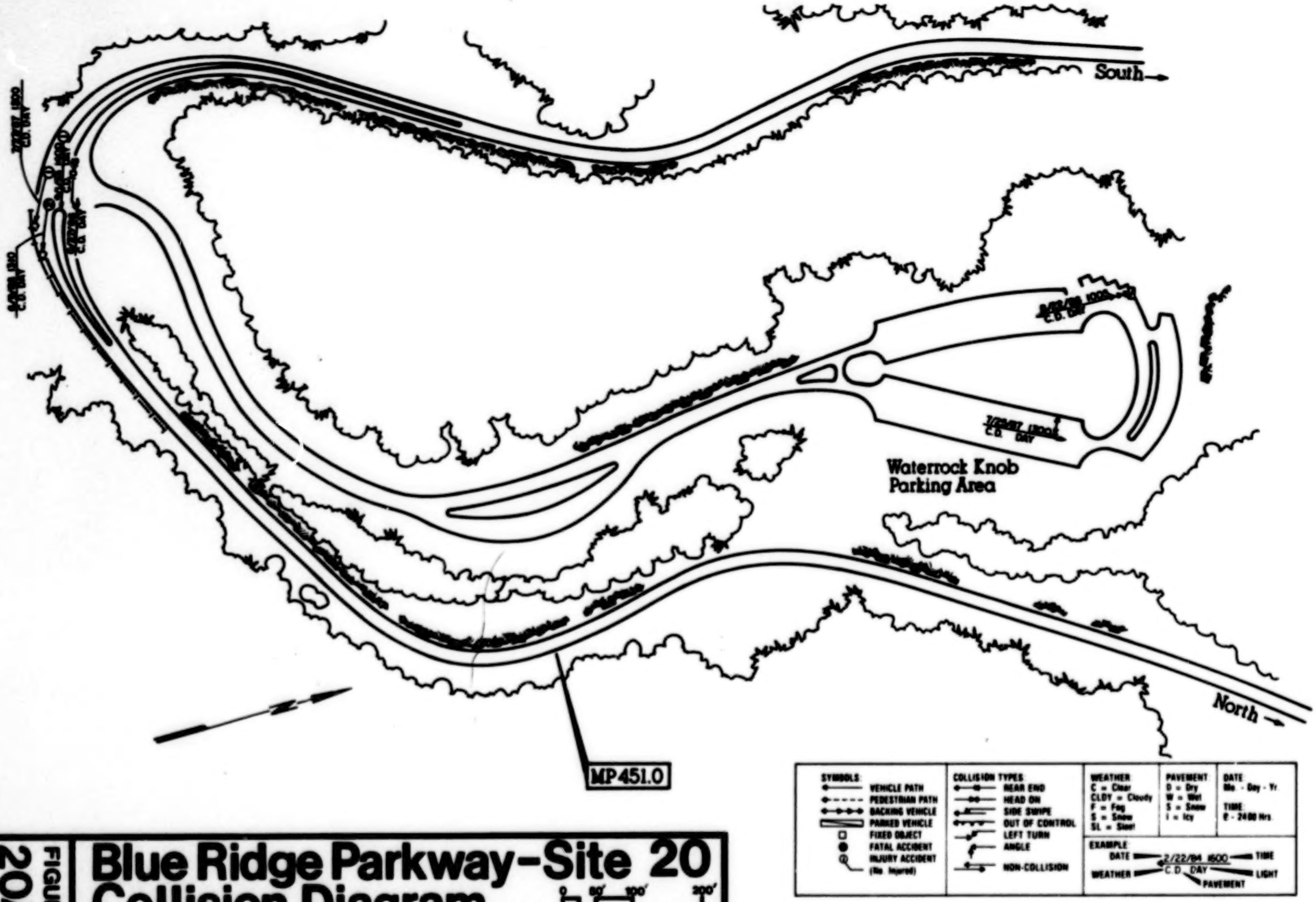


FIGURE 20A

Blue Ridge Parkway-Site 20 Collision Diagram

0 50' 100' 200'
SCALE

Site Photographs

Photograph 1: Many Parkway visitors stop next to the guiderail in the curve to admire the view. Note the wear on the shoulder resulting from heavy vehicle use.

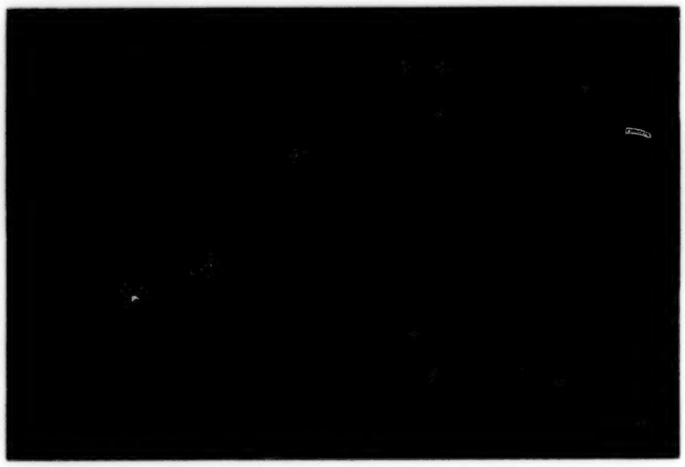
Photograph 2: This photograph shows the layout of this site. Vehicle-conflict studies at the intersection have shown that the divided road is a source of confusion for many Parkway visitors.

Photograph 3: The back slope located adjacent to the intersection blocks the view of approaching traffic.

Photograph 4: "Keep Right" signs are used to identify the ends of the medians on both approaches to the intersection.

Photograph 1

Photograph 2



Photograph 3

Photograph 4

Recommended Improvements

Based on field observations of the intersection at Waterrock Knob Overlook, it is apparent this site presents problems to many visitors. The divided highway design is often misinterpreted by people thinking the northbound lane is actually the location of the overlook. A vehicle conflict study performed at this site indicated that 19% of the approach traffic from the north and 52% from the south had difficulty negotiating the layout of this site. The most common conflicts involved vehicles on the Parkway that had to brake for turning vehicles or to avoid parked vehicles on the shoulder.

The recommended improvements provided below address the safety problems at the site:

List of Improvements	Estimated Cost
• Install painted arrows on the pavement showing the direction of travel at the ends of the medians and in the vicinity of the intersection.	$2,000.00
• Remove the "Overlook Ahead" sign and relocate the large "Waterrock Knob Overlook" signs to the locations shown in Figure 20B.	1,000.00
• Install a turn warning sign (W1-5A, 30"x30") and a 25 mph advisory speed plate (W13-1, 18"x18") on both approaches to the curve. Locate the signs as shown in Figure 20B.	600.00
• Replace the 24" stop sign with a standard stop sign (R1-1, 30"x30").	300.00
• Install a painted stop bar adjacent to the stop sign.	200.00
• Flatten the back slopes on both sides of the junction that block the view of approaching traffic.	8,000.00
• Extend the guiderail 200 feet to the south to eliminate the "volunteer pull-outs".	6,000.00
• Plant evergreen trees along the outside edge of the curve to eliminate the view from this location. This is the only effective way to discourage vehicles from stopping in the curve.	3,000.00
Total Improvement Costs:	**$21,400.00**
Benefit/Cost Ratio:	**1.09**

- Long-Term Improvement: Remove the turf median at this site and install asphalt pavement in its place. Eliminate all median signing. Provide a painted median with turn bays and painted directional arrows on the pavement to show lane usage. The wooden guide rail at this site should be replaced with a steel-backed guide rail.

Hazard Index Calculation Form

Site 20: MP MP 461.0 - 461.2, Waterrock Knob

Indicator	Data Value		Indicator Value		Weight		Partial HI's
Number of Accidents	1.5	acc/yr	33.0	x	0.164	=	5.41
Accident Rate	5.72	acc/MVE	72.0	x	0.225	=	16.20
Accident Severity	10,333	dollars	63.0	x	0.191	=	12.03
Sight Distance Ratio	.38	(wt. avg.)	100.0	x	0.074	=	7.40
Driver Expectancy	5.67	(wt. avg.)	94.5	x	0.149	=	14.08
Information System Deficiencies	5.5	(wt. avg.)	91.7	x	0.115	=	10.55

Hazard Index:	65.67
Cost of Recommended Improvements:	$21,400.00
Cost Factor:	72

Priority Index = (Hazard Index x .75) + (Cost Factor x .25)
(65.67 x .75) + (72 x .25) = 67.25

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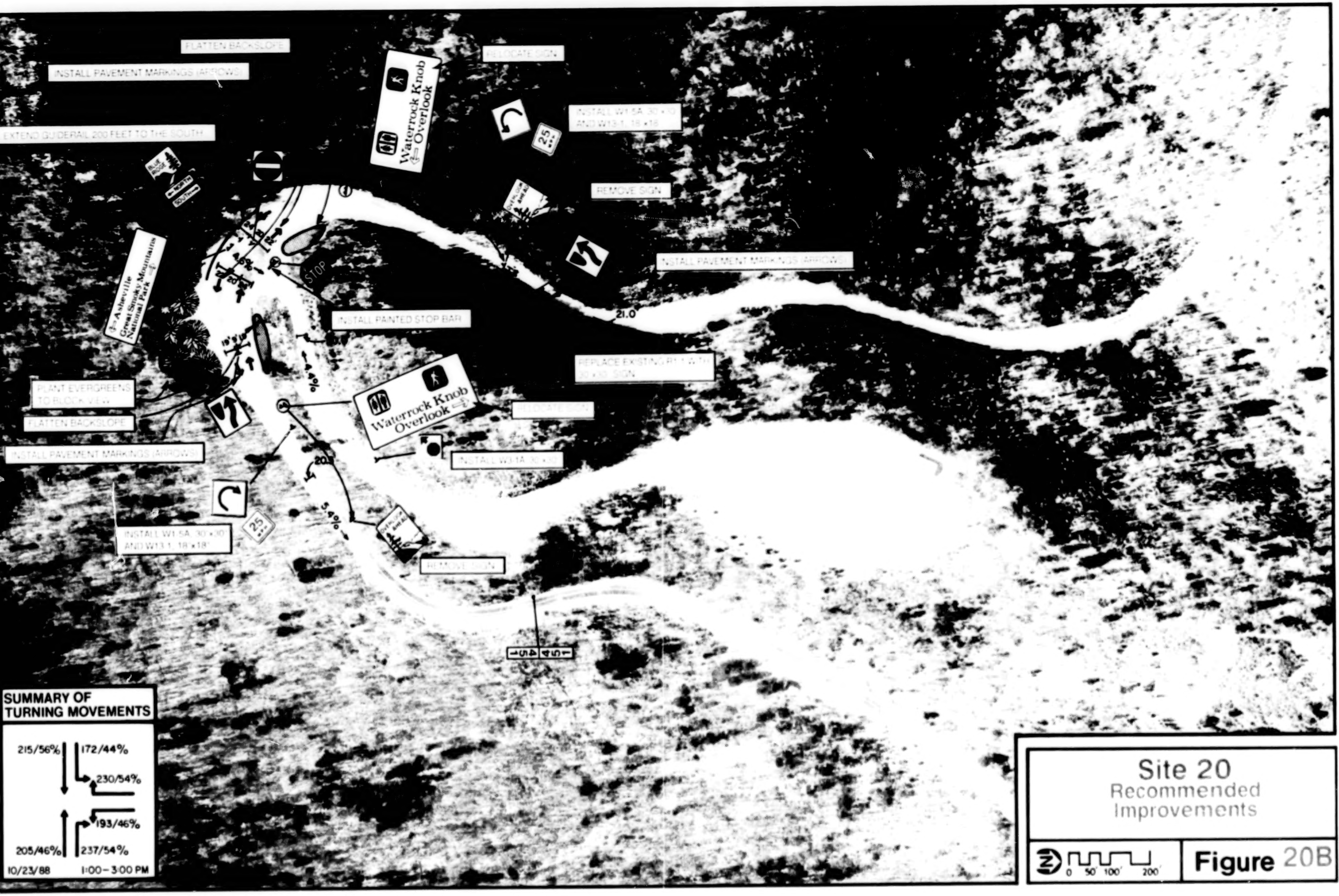
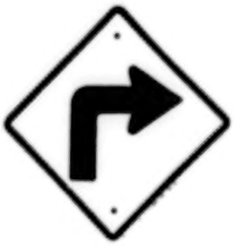

FLATTEN BACKSLOPE
INSTALL PAVEMENT MARKINGS (ARROWS)
EXTEND GUIDERAIL 200 FEET TO THE SOUTH
BLUE RIDGE
NORTH
SOUTH
Waterrock Knob Overlook
RELOCATE SIGN
INSTALL W1-5A, 30"×30" AND W13-1, 18"×18"
25 MPH
REMOVE SIGN
OVERLOOK AHEAD
INSTALL PAVEMENT MARKINGS (ARROWS)
Asheville
Great Smoky Mountains National Park
STOP
4.6%
INSTALL PAINTED STOP BAR
21.0
REPLACE EXISTING R1-1 WITH 30"×30" SIGN
19'5'19
4.4%
PLANT EVERGREENS TO BLOCK VIEW
FLATTEN BACKSLOPE
INSTALL PAVEMENT MARKINGS (ARROWS)
Waterrock Knob Overlook
RELOCATE SIGN
INSTALL W3-1A, 30"×30"
20.5
5.4%
INSTALL W1-5A, 30"×30" AND W13-1, 18"×18"
25 MPH
REMOVE SIGN
154 451
SUMMARY OF TURNING MOVEMENTS
215/56%
172/44%
230/54%
193/46%
205/46%
237/54%
10/23/88
1:00–3:00 PM
0 50' 100' 200'

Site 20
Recommended
Improvements

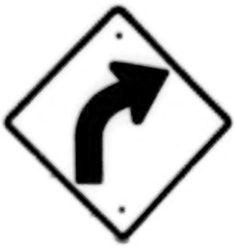
Figure 20B

Appendix A: Parkwide Curve Warning Sign Recommendations

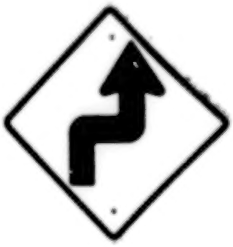
Since most of the Blue Ridge Parkway has a curved alignment, the road was evaluated to determine if existing curve signing is appropriate and where additional signing is desirable. The entire "main line" of the Parkway was driven with a vehicle equipped with a ballbank indicator to determine the maximum safe speed for curves. The following list contains milepost locations for curves with maximum safe speeds that are at least 10 mph less than the posted speed limit. Curve warning signs along with advisory speed plates are desirable at these locations. Recommended signs are shown below along with the sign reference number (as listed in the Manual on Uniform Traffic Control Devices). The standard size for curve warning signs is 30"x30" and 18"x18" for advisory speed plates. All of the warning signs recommended herein should be yellow and black in color. The appropriate curve warning sign and corresponding advisory speed plate should be installed on both the north and southbound approaches to the curve. An on-site investigation should be conducted by NPS at each curve to determine the optimum location for sign placement.



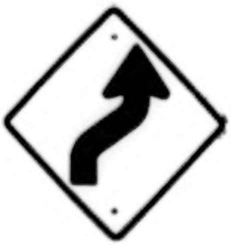
W1-1R
30" x 30"



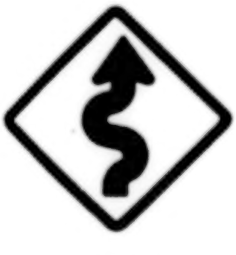
W1-2R
30" x 30"



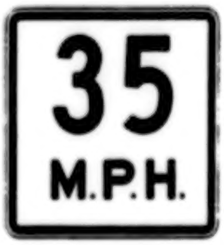
W1-3R
30" x 30"



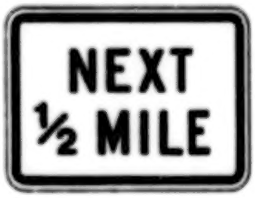
W1-4R
30" x 30"



W1-5R
30" x 30"



W13-1
18" x 18"



W7-3a
24" x 18"

The locations of all accidents during the study period were examined to determine if any of these curves had significant accident histories. The number of accidents that occurred at each of the curve locations during the 1984-1987 period is shown below. A total of 135 accidents, including 4 fatality and 59 injury accidents, occurred at 84 curve locations listed in this appendix. It is recommended that the curve locations that have an accident history be given the highest priority.

Milepost	Number of Accidents (1984 - 1987)	Recommended Sign	Recommended Advisory Speed
16.4 - 16.6	2	W1-4	35
18.9	1	W1-1	30
19.4	3	W1-1	30
20.4	0	W1-1	30
20.9	0	W1-1	30
21.1 - 21.2	2	W1-3	30
27.8	1	W1-1	30
31.4	0	W1-2	35
32.0	0	W1-4	35
35.1	1	W1-1	30
36.5 - 36.7	0	W1-3	30
37.0	4	W1-1	30
38.3	1	W1-2	35
43.9	0	W1-2	35
49.1	0	W1-2	35
51.5 - 51.6	3	W1-3	30
52.6	0	W1-2	35
54.4	0	W1-2	35
54.6	0	W1-2	35
55.2	0	W1-2	35
68.0 - 68.2	3	W1-3	25
68.8	1	W1-1	30
70.1	0	W1-3	30
71.0	0	W1-1	30
71.2 - 71.5	0	W1-5	30
71.8	1	W1-1	30
72.2 - 72.5	1	W1-5	30
73.0	0	W1-2	35
73.7	0	W1-1	30
75.9	1	W1-2	35
76.9	0	W1-2	35
77.8	0	W1-1	30
78.0	0	W1-3	25
78.7	0	W1-2	35
81.5 - 81.6	1	W1-3	30
84.1 - 84.4	1	W1-3	30
86.4	0	W1-1	30
86.8	0	W1-1	30
88.1 -88.9	6	W1-5 W7-3a (next mile)	25
89.5 - 90.0	3	W1-5 W7-3a (next 1/2 mile)	30
98.7	0	W1-2 (for southbound only)	35
101.2	0	W1-1	35
128.8	0	W1-2	35
129.2	0	W1-1	30
129.5	1	W1-1	30
132.4	0	W1-2	35
137.6 - 138.1	1	W1-5	30
138.5	2	W1-1	30

Milepost	Number of Accidents (1984 - 1987)	Recommended Sign	Recommended Advisory Speed
138.9	0	W1-2	35
139.8	0	W1-1	30
151.5 - 151.7	2	W1-3	30
152.0 - 152.1	0	W1-3	30
167.7	1	W1-1	30
168.4 - 168.5	1	W1-4	35
169.8	1	W1-2	35
216.9	1	W1-1	35
234.5	1	W1-2	35
237.6	0	W1-2	35
262.0	1	W1-2	35
264.4	0	W1-2	35
270.4 - 270.6	1	W1-4	35
273.6	2	W1-2	35
275.6	0	W1-2	35
289.8	0	W1-2	35
299.4	0	W1-2	35
301.0	1	W1-2	35
300.5	0	W1-2	35
301.8	0	W1-2	35
319.7	0	W1-2	35
320.1	1	W1-1	25
321.4	1	W1-1	30
321.9	0	W1-1	30
322.5	0	W1-1	25
323.2 - 323.7	1	W1-5	30
325.7	1	W1-1	30
331.7	0	W1-1	30
334.8 - 335.1	0	W1-5	30
336.1	0	W1-2	35
336.6	0	W1-1	30
337.2	0	W1-1	30
337.8 - 338.0	2	W1-3	30
338.1 - 338.4	0	W1-3	30
338.8 - 339.0	1	W1-4	35
339.2	0	W1-1	30
340.9	0	W1-1	25
342.7 - 342.9	0	W1-3	30
343.4	0	W1-1	30
343.7	1	W1-1	25
344.1	0	W1-2	35
344.3	0	W1-2	35
345.3	0	W1-2	35
345.6 - 345.9	1	W1-3	25
346.2	0	W1-1	25
346.8 - 347.0	1	W1-3	25
347.3	0	W1-1	30
347.8	0	W1-1	30
348.0	2	W1-1	30
348.4	0	W1-2	35

Milepost	Number of Accidents (1984 - 1987)	Recommended Sign	Recommended Advisory Speed
348.7	1	W1-1	25
349.5	1	W1-1	25
350.5	0	W1-2	35
351.3 - 351.6	1	W1-5	25
353.0	1	W1-2	35
353.9	0	W1-2	35
355.0	1	W1-1	30
356.4	0	W1-1	30
356.6	0	W1-1	30
357.1 - 357.3	0	W1-3	30
358.6	0	W1-2	35
358.8	0	W1-2	35
359.9	0	W1-1	30
360.2	0	W1-1	30
360.7	0	W1-1	30
361.9	1	W1-1	30
362.8	0	W1-1	30
364.9	2	W1-1	25
368.8 - 369.0	2	W1-3	30
369.3 - 369.5	0	W1-4	30
369.6 - 369.7	0	W1-3	25
370.4	1	W1-1	25
370.6	0	W1-1	30
371.0 - 371.2	1	W1-3	30
371.8 - 371.9	0	W1-3	25
373.3 - 373.6	1	W1-5	35
375.1	1	W1-1	30
375.3	0	W1-1	30
376.0 - 376.1	2	W1-4	35
376.5	0	W1-2	35
377.1	0	W1-2	35
377.4	0	W1-2	35
379.6	2	W1-2	35
391.9	1	W1-2	35
394.4	0	W1-2	35
401.9	0	W1-2	35
402.0	1	W1-2	35
404.0	3	W1-1	30
404.9	0	W1-1	30
405.8	0	W1-2	35
406.1	0	W1-2	35
407.9	0	W1-2	35
409.9	0	W1-1	25
410.3	1	W1-2	35
410.6	0	W1-2	35
410.9	0	W1-1	30
411.4 - 411.7	2	W1-5	30
413.0 - 413.3	2	W1-3	25
413.7	3	W1-1	25

Milepost	Number of Accidents (1984 - 1987)	Recommended Sign	Recommended Advisory Speed
414.2	1	W1-2	35
414.4	0	W1-1	30
414.9	0	W1-2	35
415.4	0	W1-2	35
415.8 - 416.0	3	W1-3	25
416.3	1	W1-1	30
416.8	0	W1-2	35
417.5	0	W1-2	35
418.0	1	W1-1	30
418.5	0	W1-1	30
421.1 - 421.3	3	W1-3	25
421.8	0	W1-1	30
424.1	0	W1-1	25
425.9	0	W1-2	35
426.8	0	W1-2	35
427.1 - 427.3	3	W1-4	35
429.8	0	W1-2	35
430.0	0	W1-2	35
431.4	0	W1-2	35
432.4	0	W1-1	30
432.8 - 433.0	0	W1-4	35
434.1 - 434.3	2	W1-3	25
436.6	0	W1-1	30
437.3 - 438.3	2	W1-5	25
		W7-31A (next mile)	
439.1 - 439.3	1	W1-3	25
440.3	0	W1-1	30
441.0	0	W1-2	35
441.5	0	W1-2	35
443.8	0	W1-2	35
444.0	0	W1-2	35
444.3	0	W1-1	30
444.6	0	W1-2	35
445.1	2	W1-1	30
445.9 - 446.4	0	W1-5	30
446.9	0	W1-2	35
447.1	0	W1-1	30
447.3	0	W1-2	35
447.5	0	W1-1	30
448.0	0	W1-1	30
448.6 - 448.7	0	W1-3	30
448.9	0	W1-2	35
449.0 - 450.2	1	W1-5	25
		W7-3a (next mile)	
450.3 - 450.5	0	W1-3	25
452.3 - 452.5	1	W1-5	30
452.7 - 452.9	2	W1-3	30
453.2	2	W1-1	25
453.7 - 453.9	1	W1-3	25

Milepost	Number of Accidents (1984 - 1987)	Recommended Sign	Recommended Advisory Speed
454.2 - 454.4	3	W1-3	25
454.6	0	W1-1	30
454.8 - 455.1	3	W1-5	25
456.5	0	W1-2	35
457.0	1	W1-2	35
458.2	1	W1-1	35
460.6	0	W1-2	35
462.6	0	W1-2	35
463.1 - 463.4	0	W1-5	25
463.8	1	W1-2	35
464.1	0	W1-2	35
464.3 - 464.6	0	W1-5	35
464.8	0	W1-2	35
464.4 - 465.5	0	W1-4	35
466.4	0	W1-1	30
466.6 - 467.1	4	W1-5	30
467.6	1	W1-1	30
468.5	0	W1-2	35

Appendix B: Recommendations for Individual Parkway Overlook Areas

All of the roadside exhibits, overlooks, and parking areas along the Parkway were examined to identify possible safety problems or deficiencies. This examination focused on three items related to traffic safety including the use of advance signing, the presence of raised median curbing, and sight distance obstructions. The roadside areas listed below were determined to have a deficiency in one or more of these categories. The listing of areas with sight distance obstructions is the result of a subjective evaluation at each site by the consultant. The general location of the obstruction (N = north of the site; S = south of the site) and the type of obstruction has been included in the listing.

It is recommended that all roadside parking areas have advanced signing. The use of curbed medians immediately adjacent to the Parkway presents an unnecessary fixed-object hazard to motorists. These medians should be removed. It is further recommended that the NPS perform a field review of each overlook listed below to determine the practicality of removing any sight distance obstructions.

Milepost	Overlook Name	No Advance Signing	Raised Median Curb	Sight Distance Obstruction*	Type of Obstruction
1.5	Rockfish Valley Overlook		X		
5.7	Humpback Rocks Visitor Center		X		
6.0	Coiner's Dead 'Nin'		X		
8.4	Picnic Area		X		
11.8	Hickory Springs Parking Area			S	Embankment
19.9	Slacks Overlook			S	Trees and shrubs
31.6	Still House Hollow Park			N	Trees
47.5	Indian Gap Parking Area			N	Shrubs
51.7	Appalachian Trail Pullout	X		S	Trees
52.9	Bluff Mountain Overlook		X		
53.6	Rice Mountain			S	Embankment

* N indicates problem is north of the site; S indicates problem is south of the site.

Milepost	Overlook Name	No Advance Signing	Raised Median Curb	Sight Distance Obstruction*	Type of Obstruction
57.5	Upper Otter Creek		X		
61.2	Terrapin Hill View			N	Shrubs and embankment
63.6	James River Visitor Center		X		
69.0	James River Valley Overlook			N	Trees and Embankment
71.6	Terrapin Mountain			S	Trees and shrubs
79.9	Black Rock Hill			S	Shrubs
81.9	Head Foremost Mountain			S	Trees
83.2	Falling Water Cascades	X			
90.0	Porter Mountain			N	Trees
91.8	Mills Gap James River View			N	Embankment
92.4	Peaks of Otter - Appalachian Trail Crossing			N	Embankment
95.2	Pine Tree Overlook			N	Embankment
96.4	Iron Mine Hollow	X			
96.9	Taylors Mountain View			S	Embankment
99.6	Great Valley View	X		N	Embankment
114.9	Roanoke River Overlook		X		
115.1	Pine Mountain Parking Area		X		
139.0	Cahas Mountain		X	N	Trees and shrubs
162.4	Rakes Mill Pond		X		
169.0	Rocky Knob Camping/ Information		X		
169.1	Rockknob Trail System	X			

---

* N indicates problem is north of the site; S indicates problem is south of the site.

Milepost	Overlook Name	No Advance Signing	Raised Median Curb	Sight Distance Obstruction*	Type of Obstruction
179.3	Round Meadows Overlook		X		
188.9	Ground Hog Mountain Picnic Area			N	Crest in road
189.8	Pucket Cabin			S	Fence and trees
202.7	Granite Quarry Overlook			N/S	Crest in road
238.5	Brinegar Cabin		X		
239.3	Doughton Campground		X		
241.1	Visitor Center/Gas Station		X		
242.4	Alligator Back			N/S	Rock embankment
252.8	Sheets Gap			N/S	Embankment
264.4	Land Overlook			N	Embankment
281.5	Grand View Overlook			S	Crest in road
295.9	Sim's Pond Overlook			S	Trees and shrubs
296.7	Price Lake		X	N/S	Trees, shrubs, and embankment
299.6	Calloway Peak			N/S	Embankment
299.9	Boone Fork		X		
300.5	Green Mountain Overlook			N/S	Embankment
302.0	Wilson Creek Valley		X	N/S	Embankment
302.2	Raven Rock Overlook		X	N	Embankment
302.9	Rough Ridge Parking			N	Embankment
303.6	Wilson Creek Overlook		X		
303.9	Yonahlossee Overlook		X	S	Embankment
304.4	Linn Cove			N	Embankment

* N indicates problem is north of the site; S indicates problem is south of the site.

Milepost	Overlook Name	No Advance Signing	Raised Median Curb	Sight Distance Obstruction*	Type of Obstruction
304.8	Stack Rock Parking		X	N	Embankment
306.6	Grandfather Mountain View			N	Trees and shrubs
307.5	Grandmother Mountain Parking			N/S	Trees and shrubs
307.7	Unmarked Pullout Area	X		N/S	Shrubs
310.0	Lost Cove Cliffs		X	N	Trees and shrubs
315.6	Camp Creek Overlook			N/S	Trees and shrubs
318.4	North Toe River Valley			N/S	Trees and shrubs
323.0	Bear Den Overlook			N/S	Rock embankment
326.0	Heffner Gap Overlook			S	Trees
337.2	Deer Lick Gap Overlook			N/S	Trees
338.9	Three Knobs Overlook			N/S	Rock embankment
342.2	Black Mountains Overlook			N/S	Embankment
345.3	Singecat Ridge Overlook			S	Trees and shrubs
348.7	Curtis Valley Overlook			N	Embankment
349.9	Mt. Mitchell View			N	Crest in road
350.4	Green Knob Overlook			N	Embankment and shrubs
372.1	Lane Pinnacle			S	Embankment
375.8	Bull Gap	X			
376.8	Tan Bark Ridge			N/S	Embankment
377.4	Craven Gap	X	X		
401.7	Beaver Dam Gap			S	Embankment
402.6	Stony Bald			S	Embankment

* N indicates problem is north of the site; S indicates problem is south of the site.

Milepost	Overlook Name	No Advance Signing	Raised Median Curb	Sight Distance Obstruction*	Type of Obstruction
403.6	Big Ridge Overlook			S	Embankment
407.7	Mt. Pisgah Picnic Area			N/S	Embankment and shrubs
408.3	No sign			N/S	Embankment and shrubs
409.3	Funnel Top Overlook			N/S	Embankment
410.3	View Pink Beds			N/S	Rock embankment
412.2	Wagon Road Gap Overlook		X	N	Trees and shrubs
413.2	Pounding Mill Overlook		X	N/S	Rock embankment
415.7	Cherry Cove		X	S	Trees
416.3	Log Hollow Overlook		X	N	Embankment
417.0	Looking Glass Rock		X		
418.4	East Fork Overlook		X	S	Rock embankment
418.8	Graveyard Fields Trail		X	N/S	Embankment and shrubs
419.5	John Rock			N/S	Crest in road
421.8	Fetter Brush		X	N/S	Rock embankment
422.3	Devil's Courthouse		X	S	Embankment
422.8	Mt. Hardy		X	N/S	Embankment
423.5	Courthouse Valley Overlook			N/S	Crest in road
424.5	Herrin Knob			N/S	Rock embankment
428.0	Caney Fork			N/S	Rock embankment
430.7	Cowee Mountain Overlook			N/S	Embankment
431.4	Richland Balsam			N/S	Embankment
438.9	Steestachee Bald			N/S	Embankment

* N indicates problem is north of the site; S indicates problem is south of the site.

Milepost	Overlook Name	No Advance Signing	Raised Median Curb	Sight Distance Obstruction*	Type of Obstruction
440.0	Village of Saunooke			S	Trees
441.4	Standing Rock Overlook			S	Trees
445.2	Mountain Lyn Lowry			N	Embankment
446.8	Woodfin Cascade Overlook			S	Trees and shrubs
447.9	Wesner Bald			S	Embankment
451.2	Waterrock Knob			N/S	Embankment
452.1	Cranberry Ridge			S	Trees and shrubs
452.3	Woolyback Overlook			N	Embankment
454.4	Thunderstruck Ridge Overlook		X	N/S	Embankment and trees
455.5	Soco Gap			N	Trees and shrubs
456.2	Jonothan Creek		X	N/S	Embankment
457.9	Plott Balsam				Embankment
458.2	Balsam Mountain		X		
461.8	Big Witch Overlook		X		
468.4	Oconoluftee River			S	Trees

* N indicates problem is north of the site; S indicates problem is south of the site.

Appendix C: Summary of Centerline Striping Evaluation

A. Methodology

The consultant evaluated the no-passing zones using a computerized Range Tracking System. The Range Tracking System was designed specifically to calculate and display the distance separating two vehicles as they traverse the same highway. The system consisted of two vehicles, each equipped with a distance measuring computer. These two range tracking computers were linked together by radio transmitters and receivers. The lead vehicle's computer continuously calculated the distance it traveled and transmitted this information to the computer in the rear vehicle. The rear vehicle's computer also calculated its travel distance and compared the distance to that traveled by the lead vehicle. The difference between the two readings represented the vehicle separation distance, assuming the two vehicles started at the same point and traveled the same course along the highway.

Two technicians were responsible for driving the vehicles and maintaining the vehicle separation distance. The lead vehicle was operated at a constant speed, usually 25 to 30 mph. The driver of the rear vehicle monitored the separation distance on the computer read-out and adjusted the speed of the rear vehicle to produce the desired separation.

A Traffic Engineer rode in the rear vehicle and was responsible for evaluating the passing sight distance. The eye height of the engineer was maintained at 3.5 feet above the road. The object used in the evaluation was an illuminated target attached to the back of the lead vehicle and mounted 3.5 feet above the road. Whenever, the target was in view, the roadway had acceptable passing sight distance.

The location of the beginning and end of each no-passing zone was recorded on a computer printout. This was accomplished using a push-button switch linked to the computer. When the switch was activated, the computer recorded the location.

The vehicle separation distance required by the "Manual on Uniform Traffic Control Devices" is based on the 85th percentile speed for the roadway. Since vehicle speed information was not available, the consultant established the vehicle separation distance based on the posted speed limit plus 5 mph. Therefore, a roadway having a posted speed limit of 35 mph was evaluated on the basis of 40 mph travel speeds. The minimum passing sight distances used in the evaluation are presented below:

Posted Speed Limit (mph)	Posted Limit Plus 5 mph (mph)	MUTCD Minimum Required Sight Distance (feet)
25	30	500
35	40	600
45	50	800

According to the "Manual on Uniform Traffic Control Devices", the "passing zone" must be at least 400 feet long to safely perform a passing maneuver. Therefore, following the field evaluation, the computerized data tapes were reviewed and all passing zones of less than 400 feet in length were eliminated.

A complete listing of all no-passing zone locations is presented in the next section of this report. The list contains the beginning (B) and end (E) of each no-passing zone located to the nearest hundredth of a mile. Only the no-passing zones are listed. All other portions of road are unrestricted and should be striped with a broken centerline. The no-passing zone listing was based on the Parkway milepost reference system. The list has been arranged so it reads up the page with the left and right side of the roadway centerline shown for each column of numbers. This format will enable maintenance personnel to locate the no-passing zones on both sides of the centerline while driving in only one direction.

The consultant evaluated the Parkway in 5-mile segments to minimize the potential of cumulative errors in distance measuring. Mileposts that indicate an even 5-mile distance were used as reference points (i.e., 0, 5, 10, 15, 20, 25). To re-establish a particular zone in the field, NPS should begin at the nearest 5-mile increment milepost located north of the desired zone and measure south from that point. For example, to locate a zone at MP 363.2 begin at MP 360 and measure south along the centerline a distance of 3.2 miles. This procedure must be used to accurately locate zones in the field.

SPECIAL USER'S NOTE:

A SPECIAL NOTE IS NECESSARY ABOUT THE LIMITATIONS OF THE SURVEY. THE NO-PASSING ZONES WERE ESTABLISHED USING THE SIGHT DISTANCE CRITERIA OUTLINED IN THE "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES". IT WAS NOT THE INTENTION OF THIS PROJECT TO IDENTIFY SPECIFIC STRIPING REQUIREMENTS AT SIDE ROAD INTERSECTIONS, PULLOUTS, PEDESTRIAN CROSSING AREAS, OR OTHER DEVELOPED LOCATIONS. NPS MAINTENANCE PERSONNEL SHOULD DETERMINE THE STRIPING REQUIREMENTS FOR EACH ROAD JUNCTION AND ANY OTHER LOCATION WITH MAIN ROAD ACCESS OR PEDESTRIAN ACTIVITY, SUCH AS ROADSIDE PULLOUTS OR OTHER ATTRACTIONS. THOSE JUNCTIONS AND PULLOUTS LOCATED WITHIN "PASSING" ZONES ARE OF PARTICULAR CONCERN. ALTHOUGH SIGHT DISTANCE IS THE PRIMARY CRITERIA USED TO ESTABLISH A PASSING ZONE, OTHER FACTORS COULD MAKE PASSING UNDESIRABLE AT A PARTICULAR LOCATION. THE AMOUNT OF VEHICLE TURNING MOVEMENTS, PEDESTRIAN ACTIVITY, AND SITE GEOMETRICS SHOULD BE CONSIDERED IN EACH CASE. IT WAS FELT THAT THE PARKWAY STAFF WOULD BE BEST SUITED TO PERFORM THIS EVALUATION BECAUSE OF THEIR FAMILIARITY WITH EACH SITE AND ITS TRAFFIC CHARACTERISTICS.

THEREFORE, IT IS ANTICIPATED THAT THE NPS MAY DETERMINE THAT PASSING ON A PORTION OF THE PARKWAY SHOULD BE RESTRICTED DUE TO ROADSIDE FACTORS. IT SHOULD BE NOTED THAT SUPERIMPOSING SUCH A "NO-PASSING" ZONE ON THE LISTING PROVIDED IN THIS REPORT COULD HAVE THE EFFECT OF CREATING ADJACENT "PASSING" ZONES OF LESS THAN 400 FEET IN LENGTH. IF THIS OCCURS, THE "NO-PASSING" RESTRICTION SHOULD BE EXTENDED TO ELIMINATE THE SHORT (LESS THAN 400 FEET) "PASSING" ZONE. CONSULT THE "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES" FOR MORE INFORMATION CONCERNING THE PROPER STRIPING OF ROADWAYS AND INTERSECTIONS.

Blue Ridge Parkway "Main Line"

LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
E 30.29			63.42 E	E 94.50	
B 27.73	30.09 E	E 62.14	62.14 B	B 94.29	94.37 E
	27.58 B	B 61.05			94.13 B
E 27.46			62.00 E	E 94.15	
B 26.66		E 60.87	60.88 B	B 93.51	94.02 E
	27.29 E	B 60.63			93.35 B
E 26.57	26.51 B		60.74 E	E 93.33	
B 25.90		E 60.55	60.46 B	B 93.07	93.08 E
	26.41 E	B 59.73			92.93 B
E 25.76	25.75 B		60.37 E		92.82 E
B 25.55		E 59.59	59.59 B		92.71 B
	25.60 E	B 58.66		E 92.98	
	25.41 B			B 90.28	92.61 E
E 25.16		E 58.51			90.15 B
B 24.71	24.99 E	B 58.07		E 90.19	
	24.56 B		59.42 E	B 89.38	90.06 E
E 24.49		E 57.93	57.99 B		89.22 B
B 24.07		B 57.20		E 89.24	
	24.36 E		57.84 E	B 84.65	89.08 E
E 23.91	23.91 B	E 57.10	57.06 B		84.45 B
B 23.44		B 55.47		E 84.52	
	23.49 E		56.96 E	B 83.88	84.37 E
E 23.36	23.30 B	E 55.38	55.33 B		83.69 B
B 19.84		B 55.14		E 83.78	
			55.20 E	B 76.38	83.60 E
E 19.75		E 55.04	50.51 B		76.22 B
B 17.51	23.22 E	B 49.96		E 76.28	
	17.34 B		50.43 E	B 75.04	76.13 E
E 17.18			49.78 B		74.90 B
B 15.88	17.04 E	E 49.73			
	15.72 B	B 45.46	49.60 E		74.70 E
E 15.39			45.27 B		70.66 B
B 11.15		E 45.08			
	15.22 E	B 43.69	44.92 E		70.53 E
E 11.01	11.01 B		43.53 B	E 74.83	66.10 B
B 7.40		E 43.38		B 65.46	
	10.83 E	B 43.31	43.26 E		66.02 E
E 7.29	7.24 B		43.15 B	E 65.34	65.31 B
B 6.58				B 65.14	
	7.12 E		42.99 E		
	6.44 B	E 43.13	41.48 B	E 64.79	
E 6.46		B 41.46		B 64.71	
B 4.21	6.26 E		41.17 E		64.69 E
	4.02 B		40.32 B	E 64.52	64.58 B
E 4.06		E 41.32		B 64.35	
B 2.14	3.91 E	B 36.23	40.24 E		
	2.01 B		36.05 B	E 64.24	
E 1.95		E 35.97		B 63.82	64.40 E
B 0.00	1.80 E	B 30.43	35.78 E		63.65 B
	0.00 B		30.27 B	E 63.56	
				B 62.30	

Blue Ridge Parkway "Main Line"

LEFT	RIGHT
E 115.46	
B 114.91	115.32 E
	114.79 B
E 114.72	
B 114.35	
	114.58 E
	114.19 B
E 114.20	
B 113.60	114.08 E
	113.45 B
E 113.37	
B 112.76	113.24 E
	112.74 B
E 112.52	
B 111.47	112.38 E
	111.41 B
E 110.96	
B 110.27	110.83 E
	110.11 B
	109.61 E
	109.42 B
E 109.73	
B 109.07	109.34 E
	108.89 B
E 108.79	
B 108.68	108.64 E
	108.53 B
E 108.40	
B 108.05	108.23 E
	108.00 B
E 107.44	
B 106.85	107.24 E
	106.68 B
E 106.75	
B 106.38	106.59 E
	104.80 B
E 106.26	
B 101.79	104.71 E
	101.61 B
E 101.70	
B 99.50	101.53 E
	99.32 B
E 99.27	
B 95.85	99.11 E
	95.77 B
E 95.65	
B 94.65	95.51 E
	94.58 B

LEFT	RIGHT
	136.34 E
E 135.48	135.82 B
B 135.23	
E 135.15	
B 131.23	
	135.32 E
E 131.13	131.13 B
B 128.68	
	130.97 E
	128.53 B
	128.13 E
E 128.60	126.42 B
B 125.30	
	126.22 E
E 125.18	125.14 B
B 125.04	
E 124.79	
B 123.21	125.00 E
	122.96 B
E 122.76	
B 122.62	
	122.65 E
E 122.48	122.47 B
B 121.33	
E 121.24	
B 119.43	122.36 E
	119.30 B
E 119.16	
B 118.28	119.02 E
	118.14 B
E 118.19	
B 117.95	118.06 E
	117.78 B
E 117.73	
B 117.50	117.61 E
	117.35 B
	116.99 E
	116.70 B
E 117.15	
B 116.52	116.60 E
	116.43 B
E 116.08	
B 115.70	116.01 E
	115.54 B

LEFT	RIGHT
	152.86 E
	152.18 B
E 153.01	
B 151.37	152.09 E
	151.07 B
E 150.88	
B 150.75	
	150.76 E
E 150.67	150.67 B
B 150.51	
	150.52 E
	150.43 B
E 150.36	
B 149.68	150.24 E
	149.54 B
E 149.28	
B 149.04	149.14 E
	148.89 B
	148.80 E
	148.31 B
	148.19 E
	146.87 B
E 148.94	
B 146.36	146.71 E
	146.19 B
	146.09 E
E 146.25	145.29 B
B 145.27	
E 145.13	
B 143.50	
	145.00 E
E 143.34	143.37 B
B 142.30	
	143.20 E
E 142.17	142.16 B
B 141.90	
	142.01 E
E 141.45	141.73 B
B 140.34	
	141.31 E
E 140.13	140.18 B
B 136.74	
	140.00 E
E 136.66	136.42 B
B 135.94	

Blue Ridge Parkway "Main Line"

LEFT	RIGHT
E 178.90	
B 178.62	178.77 E
	178.49 B
E 178.50	
B 178.03	178.35 E
	177.90 B
E 177.91	
B 177.46	
	177.75 E
	177.35 B
E 177.35	
B 173.73	177.22 E
	173.56 B
E 173.61	
B 173.26	
	173.46 E
E 173.11	171.44 B
B 171.58	
	171.27 E
E 171.40	169.46 B
B 169.61	
	169.30 E
	165.36 B
E 169.45	
B 165.05	165.26 E
	164.93 B
E 164.64	
B 162.35	164.49 E
	161.86 B
E 162.26	
B 162.00	
E 161.82	
B 160.61	161.69 E
	160.47 B
	160.16 E
	159.93 B
E 160.30	
B 156.85	159.81 E
	156.71 B
E 156.74	
B 155.60	156.60 E
	155.46 B
E 155.24	
B 154.42	155.11 E
	154.33 B
E 154.27	
B 153.13	154.15 E
	152.96 B

LEFT	RIGHT
E 192.04	
B 191.71	
	192.60 E
E 191.59	191.57 B
B 191.38	
	191.44 E
	191.24 B
E 190.93	
B 189.70	190.76 E
	189.64 B
E 189.61	
B 189.10	
	189.47 E
E 189.02	188.97 B
B 188.00	
	188.87 E
	187.88 B
E 187.82	
B 187.42	187.71 E
	187.26 B
E 187.12	
B 186.36	186.98 E
	186.30 B
E 186.26	
B 185.79	186.12 E
	185.63 B
	185.36 E
E 185.54	184.44 B
B 184.24	
	184.35 E
E 184.07	184.07 B
B 183.92	
E 183.84	
B 183.35	183.94 E
	183.24 B
E 183.25	
B 183.07	183.09 E
	182.94 B
E 182.91	
B 182.32	182.76 E
	182.22 B
E 182.20	
B 181.95	182.02 E
	181.82 B
E 181.73	
B 179.01	181.58 E
	178.87 B

LEFT	RIGHT
	210.22 E
E 209.01	209.07 B
B 208.00	
	208.87 E
E 207.87	207.85 B
B 207.42	
	207.75 E
E 207.12	207.27 B
B 203.90	
	206.98 E
	205.12 B
	204.96 E
	203.78 B
E 203.82	
B 203.54	203.66 E
	203.40 B
E 203.29	
B 202.68	203.17 E
	202.54 B
E 202.57	
B 202.44	202.44 E
	202.29 B
E 202.27	
B 201.71	
	202.18 E
E 201.54	201.57 B
B 197.21	
	201.37 E
E 197.09	197.05 B
B 195.73	
	196.95 E
E 195.47	195.58 B
B 195.40	
E 194.95	
B 194.55	194.78 E
	194.38 B
E 194.22	
B 193.92	
E 193.79	
B 193.69	
E 193.43	
B 193.27	194.04 E
	193.08 B
E 192.74	
B 192.15	

Blue Ridge Parkway "Main Line"

LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
E 247.12			283.34 E		312.15 E
B 246.93	247.01 E		281.99 B		311.79 B
	246.81 B			E 311.78	
E 246.46			281.81 E	B 308.71	311.65 E
B 245.75	246.29 E	E 281.97	281.30 B		309.72 B
	245.95 B	B 277.56		E 308.63	
E 245.67		E 277.45		B 303.54	309.56 E
B 244.11	245.88 E	B 273.14	281.21 E		303.46 B
	243.93 B		273.03 B		
		E 272.97			303.27 E
	243.70 E	B 267.61	272.81 E		302.08 B
E 243.85	241.57 B		267.52 B	E 303.35	
B 240.95				B 300.13	301.89 E
	241.11 E		267.27 E		299.17 B
E 240.82	240.82 B	E 267.49	267.20 B		
B 239.23		B 266.25			299.09 E
	240.72 E		267.09 E	E 298.88	298.87 B
	239.08 B	E 266.10	266.09 B	B 297.95	
		B 265.85			298.72 E
	238.94 E		265.93 E		297.77 B
	236.07 B		265.74 B	E 297.61	
		E 265.52		B 297.41	
	235.99 E	B 263.81			297.52 E
	235.92 B		265.40 E	E 297.32	297.23 B
E 239.10		E 263.70	263.66 B	B 295.13	
B 231.93	235.81 E	B 263.59			297.12 E
	231.80 B	263.31	E	E 294.96	294.95 B
E 231.78		E 263.50	260.74 B	B 292.44	
B 231.23		B 258.55			
	231.66 E		260.62 E	E 292.34	
E 231.07	231.09 B		258.40 B	B 288.92	
B 229.17		E 258.28			
	230.98 E	B 255.98	258.26 E	E 288.91	
E 229.02	229.02 B		255.84 B	B 287.60	294.80 E
B 222.76					287.47 B
	228.89 E		255.44 E	E 287.31	
	222.62 B		254.68 B	B 286.75	
E 222.63					287.15 E
B 215.21	222.50 E		254.55 E	E 286.61	286.60 B
	215.10 B		250.68 B	B 286.29	
		E 255.62			286.43 E
	214.92 E	B 248.57	250.59 E	E 286.18	286.14 B
E 214.85	214.87 B		248.38 B	B 285.46	
B 212.62		E 248.32			286.02 E
	214.71 E	B 247.79	248.16 E		285.34 B
E 212.43	212.47 B		247.61 B		
B 210.61					285.19 E
	212.29 E		247.43 E	E 285.35	283.44 B
E 210.36	210.47 B		247.37 B	B 282.11	
B 209.21					

Blue Ridge Parkway "Main Line"

LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
E 385.18			435.22 E	E 469.10	
B 383.37	385.01 E		433.74 B	B 466.13	469.10 E
	383.20 B				462.04 B
E 383.24			433.66 E	E 466.03	
B 378.64			432.64 B	B 462.20	
			432.49 E		
E 378.64		E 435.36	431.20 B	E 462.02	
B 366.29		B 429.17		B 458.16	461.91 E
	383.08 E		431.09 E		458.04 B
E 369.64	360.94 B	E 429.07	429.02 B	E 458.08	
B 360.51		B 419.77		B 457.68	457.95 E
	360.83 E		428.92 E		457.53 B
E 360.35	360.35 B		419.63 B	E 457.45	
B 355.61		E 419.65		B 448.28	457.32 E
		B 412.63	419.49 E		448.21 B
E 355.50			408.92 B	E 448.19	
B 342.47		E 412.54		B 445.87	448.06 E
	360.18 E	B 409.06			445.73 B
E 342.34	342.31 B			E 445.76	
B 329.71		E 408.95		B 438.67	445.62 E
	342.21 E	B 406.05	408.83 E		438.47 B
	329.59 B		405.92 B	E 438.52	
E 329.62				B 436.34	438.36 E
B 329.42	329.45 E		405.82 E	436.19	B
	329.28 B		404.35 B	E 436.25	
		E 405.95		B 435.46	
	329.13 E	B 400.28	404.08 E		436.11 E
	327.11 B		400.11 B		435.31 B
			400.00 E		
	326.92 E	E 400.15	394.75 B		
	326.83 B	B 394.35			
E 329.27			394.67 E		
B 325.54	326.73 E		394.21 B		
	325.39 B				
E 325.43			393.99 E		
B 325.08	325.30 E		393.80 B		
	324.89 B	E 394.12			
E 324.84		B 393.56	393.65 E		
B 324.64	324.75 E		393.42 B		
	324.48 B	E 393.36			
E 324.23		B 390.37	393.19 E		
B 316.72			390.10 B		
	324.08 E	E 389.88			
	316.56 B	B 389.54	389.75 E		
			389.40 B		
	316.46 E	E 389.24			
E 316.57	314.85 B	B 388.66	389.10 E		
B 313.24			388.56 B		
	314.77 E	E 388.19			
E 312.32	312.23 B	B 385.45	388.02 E		
B 311.94			385.28 B		

Mill Mountain Road

Stop Sign at Parkway Junction = MP 0.0

LEFT		RIGHT	
E	2.39	2.39	E
B	1.92	1.81	B
E	1.74	1.64	E
B	0.95	0.83	B
E	0.71	0.58	E
B	0.00	0.00	B

Linville Falls Road

Stop Sign at Parkway Junction = MP 0.0

LEFT		RIGHT	
E	21.39	1.39	E
B	1.17	1.26	B
E	1.05	1.14	E
B	0.00	0.00	B

Heintooga Road

Stripe Entire Road Double-Solid

Appendix D: Calculation of the Hazard Index and the Priority Index

A hazard index, based on six indicator values, was calculated for each high-accident location. Three of these indicators are related to the accident history at the site. They include number of accidents, accident rate, and accident severity. The other three are related to the physical and operational characteristics of the site including sight distance, driver expectancy, and information system deficiencies.

A value ranging from 0 to 100 was calculated for each indicator, with 0 representing no hazard and 100 representing the most hazardous condition. The indicator values were then weighted and summed to yield the Hazard Index. The values for each indicator were determined from graphs developed by the Federal Highway Administration (FHWA). The hazard index calculation form shown in Figure D1 includes the weighted values for each indicator.

The costs of the improvements at each site were estimated using current construction costs and evaluated against the accident-reduction benefits associated with the type of improvement. A cost factor was determined in addition to this benefit/cost ratio. The cost factor represents the improvement costs per vehicle and is computed by dividing the total cost of the recommended improvements by the number of vehicles entering that location over a period of five years. A five-year period is used because it is the average service life of most recommended improvements. The form used to compute the cost factor is shown in Figure D2.

The final phase in the analysis was the determination of the priority index (PI). The priority index is the weighted average of the hazard index (HI) and the cost factor (CF) as shown in the following equation:

$$PI = 0.75\,(HI) + 0.25\,(CF)$$

The site improvements were then ranked according to the priority index. The following section contains a brief explanation of the procedures used to calculate each hazard indicator and the benefit/cost ratio for each high-accident location.

1. Number of Accidents

Accident records for a four-year period from January, 1984, through December, 1987, were obtained from the National Park Service. This accident data was then used to determine the annual average number of accidents which occurred at each site. The relationship between the annual number of accidents and the indicator value is shown in the graph contained in Figure D2.

Figure D1
Hazard Index Calculation Form

Site ______________________________

Indicator	Data Value	Indicator Value	Weight	Partial HI's
Number of Accidents	______ acc/yr	______	x 0.164 =	______
Accident Rate	______ acc/MVE	______	x 0.225 =	______
Accident Severity	______ dollars	______	x 0.191 =	______
Sight Distance Ratio	______ (wt. avg.)	______	x 0.074 =	______
Driver Expectancy	______ (wt. avg.)	______	x 0.140 =	______
Information System Deficiencies	______ (wt. avg.)	______	x 0.115 =	______

Hazard Index: ______________

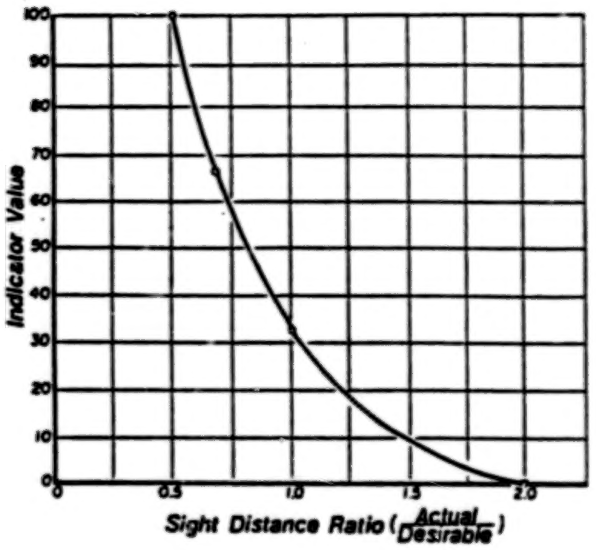
Cost of Recommended Improvements: ______________

Cost Factor: ______________

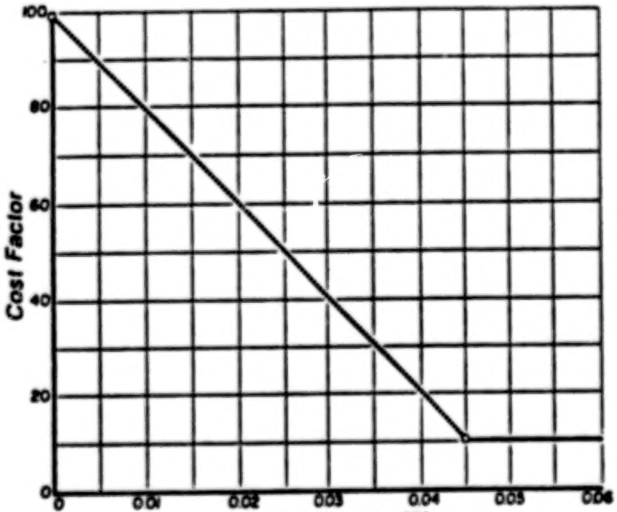
Priority Index = (Hazard Index x .75) + (Cost Factor x .25)

(________ x .75) + (__________ x .25) = ________

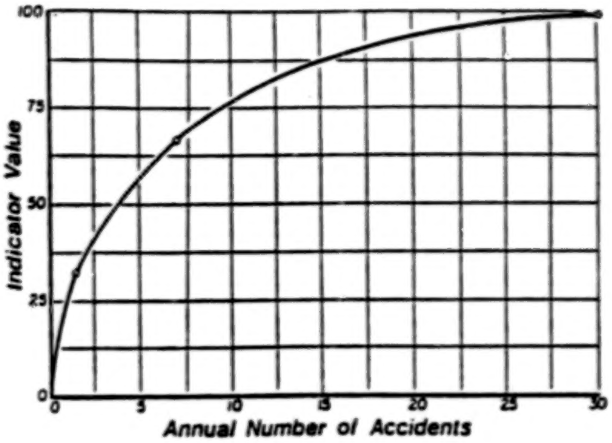
Figure D2
Hazard Indicator Values



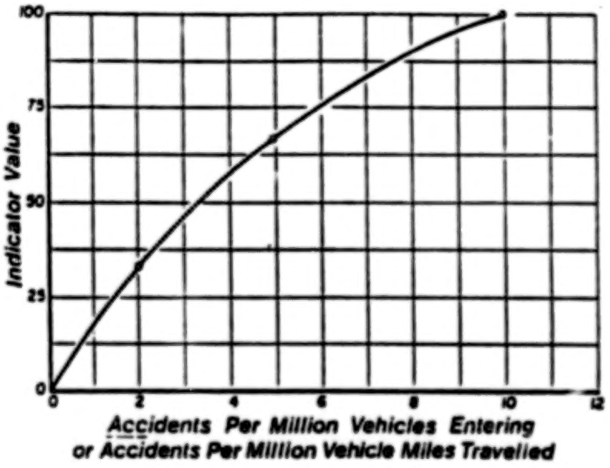
INDICATOR VALUES FOR SIGHT DISTANCE



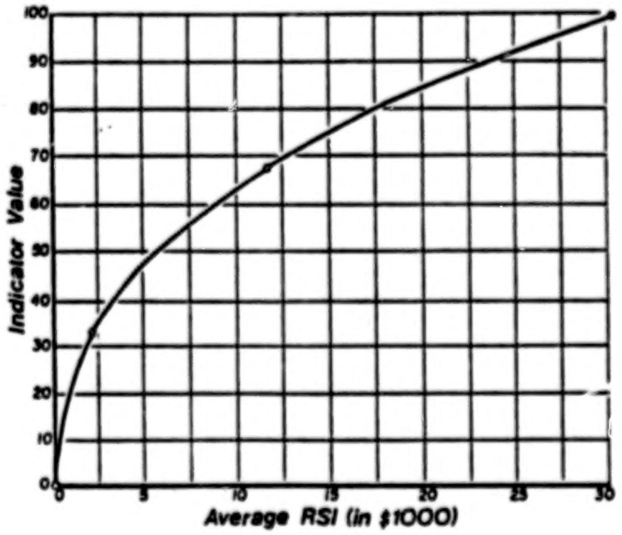
FORM FOR DETERMINATION OF COST FACTOR



INDICATOR VALUES FOR NUMBER OF ACCIDENTS



INDICATOR VALUES FOR ACCIDENT RATE



INDICATOR VALUE FOR ACCIDENT SEVERITY

2. Accident Rate

This indicator is used to compensate for the wide range of traffic volumes found throughout the Parkway. The average daily traffic entering each site was calculated and adjusted to represent a four-year volume. The total number of accidents per million vehicles entering the site was then calculated and used to develop the accident rate. The accident rates were entered into the appropriate graph on Figure D2 to yield the corresponding indicator values.

3. Accident Severity

This indicator considers the severity of the accidents which occurred at each site in terms of dollars. Table D-1 contains the "Relative Severity Index" (RSI) which was used to categorize each accident by type and to assign a corresponding accident cost. The average of the RSI values at each site was calculated and entered into the appropriate graph on Figure D2 to determine the indicator value.

4. Sight Distance

The sight distance that is available at a location is an excellent indicator of the hazardousness of that site. Critical sight distances were measured, and the desirable sight distances for each location were then calculated according to the AASHTO publication, A Policy on Geometric Design of Highways and Streets. The ratio of existing versus the desirable sight distance was calculated for each hazardous location. This sight distance ratio was entered into the appropriate graph on Figure D2 to identify the corresponding indicator value.

5. Driver Expectancy

The driver expectancy indicator is a purely subjective method of evaluating the ability of the average motorist to negotiate a section of road or an intersection. Each approach to the site was rated using the criteria included on the driver expectancy form shown on Figure D3. The site was independently evaluated by two technicians and the ratings for each approach were averaged. The two approaches with the worst ratings were used in the calculation of the indicator value. A weighted average of both ratings was calculated and used to compute the indicator value for driver expectancy.

6. Information System Deficiencies

This indicator is based on subjective evaluation similar to the driver expectancy ratings. This rating considers the signing and striping systems at each site with respect to their ability to provide information and guide the motorist through a section of road or intersection. The criteria used in this evaluation are shown on Figure D3.

All approaches to the site were independently rated by two technicians and their ratings were averaged. Only the two worst ratings were used to calculate this indicator. A weighted average of the ratings was used to yield the appropriate indicator values.

Table D-1
Relative Severity Index by Type of Accident*

	Rural
Multi-Vehicle, at Intersection	
Entering at angle	$14,400
From same direction - both going straight	5,100
From same direction - one turn, one straight	5,100
From same direction - one stopped	5,200
From same direction - all others	6,300
From opposite direction - both going straight	20,000
From opposite direction - one left turn, one straight	15,400
From opposite direction - all others	3,800
Multi-vehicle, Non-Intersection	
Going opposite direction - both moving	$19,600
Going same direction - both moving	8,100
One car parked	2,400
One car stopped in traffic	6,800
One car entering parked position	2,300
One car leaving parked position	2,700
One car entering alley or driveway	6,000
One car leaving alley or driveway	4,400
All others	7,600
Motor Vehicle with Pedestrian, at Intersection and Non-Intersection	
Vehicle going straight	$49,000
Vehicle going right	11,200
Vehicle turning left	11,200
Vehicle backing	11,200
All others	11,200
Single Vehicle, at Intersection	
Collision with bicycle	$31,900
Collision with fixed object in road	7,000
Overturned in road	7,500
Left road	12,300
Single Vehicle, Non-Intersection	
Collision with bicycle or pedestrian	$31,900
Collision with fixed object in road	9,200
Overturned in road	9,400
Left road at curve	12,400
Left road on straight road	10,500
Other One Motor Vehicle, at Intersection and Non-Intersection	
Fell from moving vehicle	$57,200
Collision with animal	1,800
Collision with other object	4,400
All others	2,000

* FHWA-RD-77-87 "Identification of Hazardous Locations"

Figure D3
Rating Forms and Indicator Values for Driver Expectancy and Information System Deficiencies

Driver Expectancy Problems Rating Form

Ratings

0 Nothing unexpected or unusual at this location
Actions required (if any) entirely consistent with driving strategy on approach
Standard geometry, with pathway(s) for intended movement(s) clearly evident.
No interferences by other traffic likely

1

2

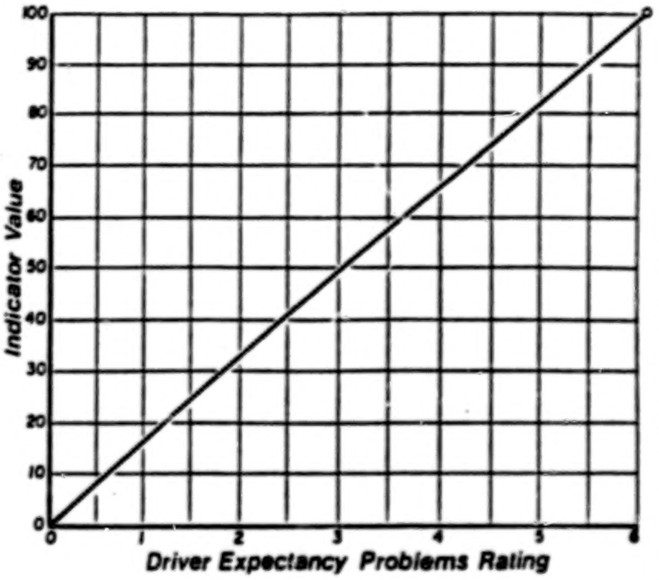
3 Situation somewhat unexpected.
Driver must be alert, but should be able to respond adequately at "last minute" to most combinations of adverse circumstances
Some initial confusion on intended path(s) or movement(s)
Interference from other traffic may create some degree of confusion or uncertainty for average driver

4

5

6 Very unusual situation; will surprise many unfamiliar drivers.
Driver required to make major changes in driving tactics from those employed over the past few miles.
At least a "near accident" almost expected if driver is even marginally inattentive, evasive actions likely to be required.
Intended pathway(s) confusing under fairly normal traffic or lighting conditions.
Other traffic, or lack of it, aggravates situation and misleads driver or deprives him of important cues

Approach	Rating 0	1	2	3	4	5	6
A							
B							
C							
D							



INDICATOR VALUES FOR DRIVER EXPECTANCY

Information System Deficiencies Rating Form

Ratings

0 Information for required decisions complete and unambiguous.
Signs, markings, delineation in good repair, clean, highly visible
"Positive guidance" leads driver to appropriate path, makes "error" difficult
Approach speeds of most drivers are appropriate
Light decision load; easy and obvious

1

2

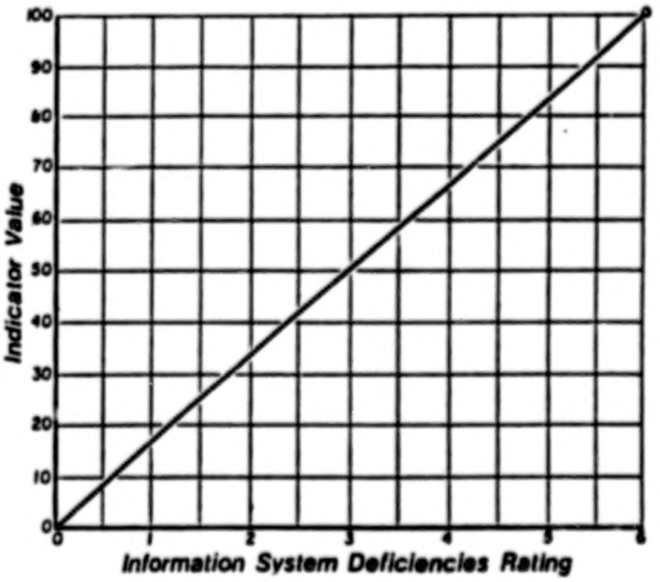
3 Some information lacking or somewhat misleading.
Signs should be moved or augmented for better visibility or to provide more decision time.
Visibility of signs, marking, and delineation barely adequate
Medium decision load, average driver will be able to handle situation, but may be a little uncomfortable

4

5

6 Important information missing.
Complete new "information system" needed - design and installation.
Present signs and markings in very poor condition; need replacement.
Speed limit and/or advisory speed needed, either missing or totally inappropriate at present.
"Positive guidance" on appropriate path lacking, a clutter of negative delineation only.
Heavy decision load; complete attention of average driver required; a "tense" situation at best.

Approach	Rating 0	1	2	3	4	5	6
A							
B							
C							
D							

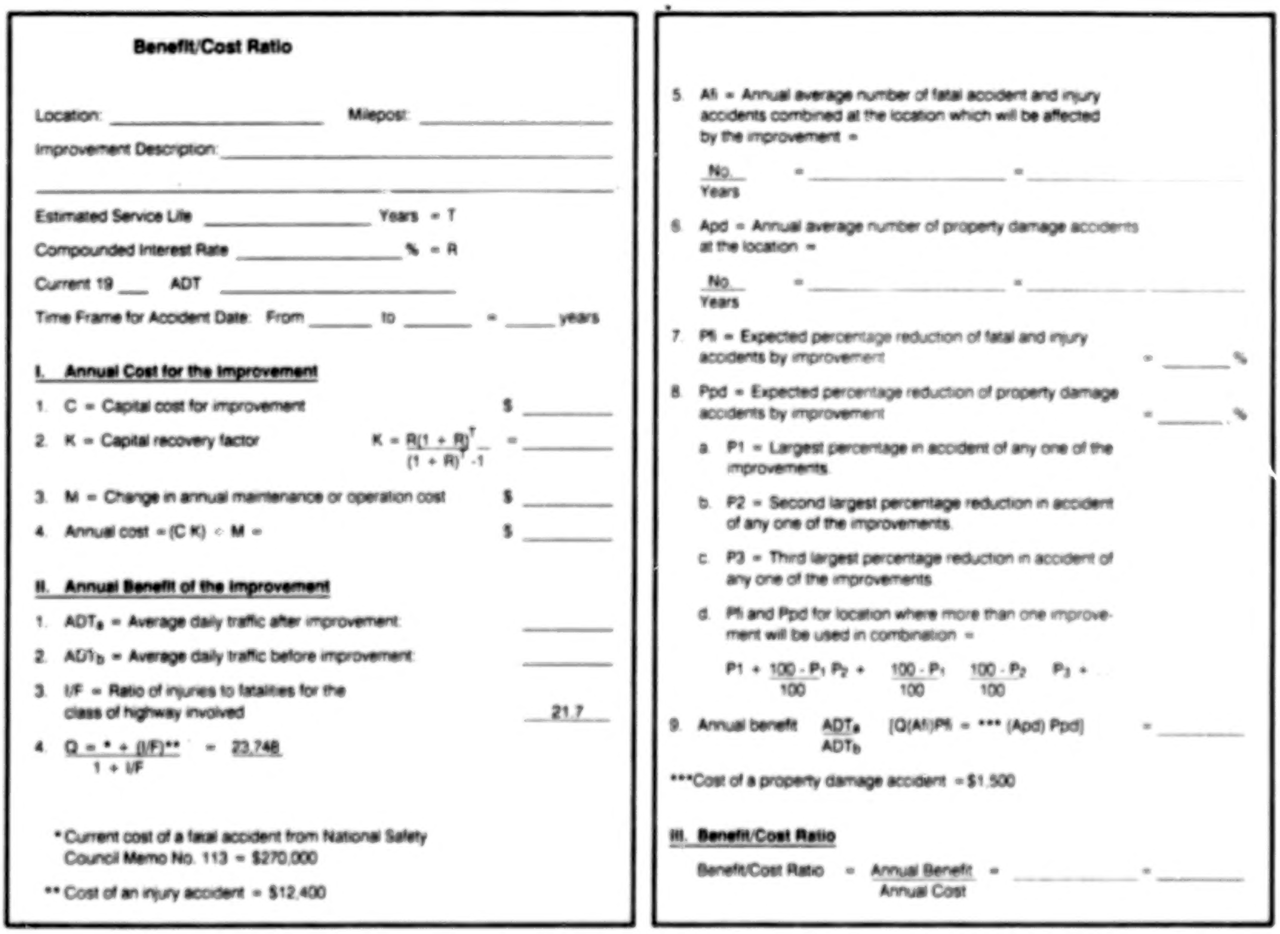


INDICATOR VALUES FOR INFORMATION SYSTEM DEFICIENCIES

7. Benefit/Cost Ratio

High-accident locations were analyzed and improvements were recommended to address identifiable problems at each site. The costs of the improvements were estimated based on bid tabulations from recent NPS projects or current average construction costs and compared to the benefits each was likely to produce at the sites. The benefits were calculated based on the anticipated accident reduction for the improvements. Accident reduction levels were estimated based on information contained in a 1982 FHWA publication entitled "Accident Reduction Levels Which may be Attainable from Various Safety Improvements." The method used to calculate the benefit/cost ratios for the high-accident locations is shown in Figure D4.

Figure D4
Benefit/Cost Ratio Calculation Form



Benefit/Cost Ratio

Location: ____________________ Milepost: ____________________

Improvement Description: ____

____

Estimated Service Life ______________ Years = T

Compounded Interest Rate ______________ % = R

Current 19 ___ ADT ____________________

Time Frame for Accident Date: From ______ to ______ = _____ years

I. Annual Cost for the Improvement

1. C = Capital cost for improvement $ ________
2. K = Capital recovery factor $K = \frac{R(1 + R)^T}{(1 + R)^T - 1}$ = ________
3. M = Change in annual maintenance or operation cost $ ________
4. Annual cost = (C K) + M = $ ________

II. Annual Benefit of the Improvement

1. ADT_a = Average daily traffic after improvement: ________
2. ADT_b = Average daily traffic before improvement: ________
3. I/F = Ratio of injuries to fatalities for the class of highway involved 21.7
4. $Q = \frac{{*} + (I/F){**}}{1 + I/F} = 23{,}748$

* Current cost of a fatal accident from National Safety Council Memo No. 113 = $270,000

** Cost of an injury accident = $12,400

5. Afi = Annual average number of fatal accident and injury accidents combined at the location which will be affected by the improvement = $\frac{\text{No.}}{\text{Years}}$ = ______________ = ______________
6. Apd = Annual average number of property damage accidents at the location = $\frac{\text{No.}}{\text{Years}}$ = ______________ = ______________
7. Pfi = Expected percentage reduction of fatal and injury accidents by improvement = ______ %
8. Ppd = Expected percentage reduction of property damage accidents by improvement = ______ %
   - a. P1 = Largest percentage in accident of any one of the improvements.
   - b. P2 = Second largest percentage reduction in accident of any one of the improvements.
   - c. P3 = Third largest percentage reduction in accident of any one of the improvements.
   - d. Pfi and Ppd for location where more than one improvement will be used in combination =

$$P1 + \frac{100 - P_1}{100} P_2 + \frac{100 - P_1}{100} \cdot \frac{100 - P_2}{100} P_3 + \ldots$$

9. Annual benefit $\frac{ADT_a}{ADT_b}$ [Q(Afi)Pfi = *** (Apd) Ppd] = ________

***Cost of a property damage accident = $1,500

III. Benefit/Cost Ratio

Benefit/Cost Ratio = $\frac{\text{Annual Benefit}}{\text{Annual Cost}}$ = ______________ = ________

END

3 — 30 — 92